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THE DERRIEY CYLINDER PRESS.

THE increased circulation of our daily papers has called forth various improvements in printing presses, and, naturally, the Paris Exhibition was amply supplied with presses of all descriptions. Among those destined for printing large daily editions of newspapers, the presses exhibited by Mr. Jules Derriey, of Paris, appear, for various reasons, to deserve special notice. Mr. Derriey exhibited two kinds of presses. In one the paper is cut before, in the other after, the impression has been received. Our engraving represents the former kind.

The paper, previously moistened, is unrolled and fed by two cylinders to the cutters at such a rate that a sheet of the required size is cut off for every impression. The size of the sheet increases with the speed of the feeders.

The severed sheet receives the first impression by a cylinder located near the center of the machine. The cylinder making the second impression is situated at the extremity opposite the feeders, and easily accessible to facilitate the insertion of dispatches, etc., arriving late.

The printed sheets are conducted to an accumulator, placed above the cylinder making the second impression, and are from there removed, in counted packages of 100 each, to the receiving table.

The position of the inkers, the accumulator, and the receiver is plainly illustrated by the engraving. The ink is distributed by six composition rollers and three metal cylinders.

It is of great importance to have the paper uniformly moistened before introducing it into the press, especially when, as in France mostly, the paper is of poor quality. Mr. Derriey has therefore constructed a moistening machine, insuring the uniform distribution of water throughout the paper to any desired degree.

The water is contained in a tub, in which revolves an iron cylinder, partially immersed in the water. By two cylinders the paper is unrolled and forced to pass over the cylinder in the tub. The surface of this latter cylinder, when emerging from the water, carries enough of the latter with itself to moisten the paper sufficiently. The latter is then again rolled up and allowed to stand twenty-four hours before being used.

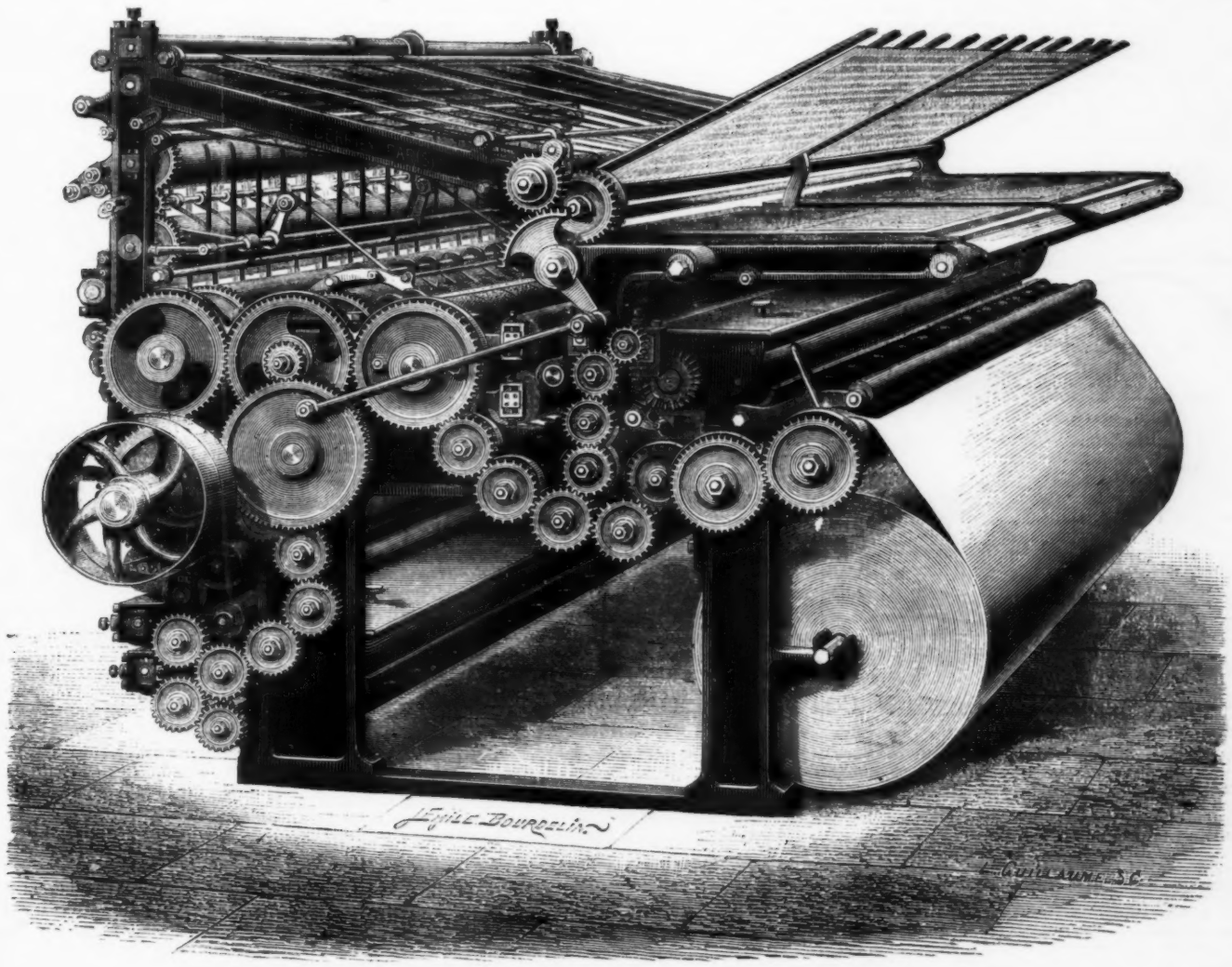
The press described can print sheets of any size not exceeding four feet in length and three feet in width. Its area of base is very large compared with its height; hence, it stands very firm and stable. The different parts of the press may be inspected and regulated easily, no climbing up and down being necessary. Ten thousand copies of a paper of the size mentioned can be printed per hour with this machine. Of a paper only half as big, double the number of copies may be furnished, two copies being printed at a time.

There are about thirty of these presses in use at present. Of the journals printed by them we mention the "Moniteur Universel," the "République Française," and the "Temps."—*Revue Industrielle.*

THE DIGNITY OF LABOR.

A COMMON phrase in men's mouths is "the dignity of labor." This may mean a great deal; but on the lips of men from the worthiness of honest work to the worthlessness of shams. As things are rated in all open markets by their actual value, the result is inevitable. The Dignity of Labor may be regarded as so much actual and productive capital. The indignity of dishonest work—the mere pretense—is discovered and exposed.

Just so long as competitors keep in view the retail market and the individual judgment of consumers, will they maintain themselves in repute. Peter Pindar's razors no doubt looked well in the package, and could pass through the hands of middlemen unchallenged; but when poor Hodge with his stubble field of beard put the article to the test, the cheat was discovered, and the fact confessed that the razors were not made to shave, but to *sell*. Hodge did not want another of "the same sort," as the famous razor seller in the streets of our city of New York forty years ago used to cry his razors. "The same sort" in his case meant a good sort; and though he never used the phrase, "the dignity of labor," that razor man was a good street preacher of it.



FAST STEAM PRINTING PRESS, AT THE PARIS EXHIBITION.

Cheap and serviceable is the outcome of improved machinery and processes. It is no objection to a good thing that it is sold at a price nominally low. The fair line of competition, when prices have reached their minimum, is to raise their intrinsic value; and when that is done, the tendency of prices is upward again. Still farther to cheapen in nominal price, with a correspondent deficiency in value, is to descend to the "cheap and nasty," with a tendency to still lower prices. A far-seeing man makes the first loss in sacrificing himself—a loss which usually turns to gain. A short-sighted one makes his customers the first losers, and becomes himself the last and heaviest.

The view which is here taken of the dignity of labor, as depending upon its thoroughness and honesty, is one which every man, whatever his line, may take and act upon. Nobody ever yet was impoverished by honesty. Honest men may be and often are poor, but their honesty is not to blame for it. Other causes, deficiencies in other respects, may be against them, obstacles inherent in themselves or presented by circumstances. Their honesty saves them from worse consequences. The poor knave is the wretchedest being on earth. But he who has lost all but honor has still something left to live for, since he has not forfeited his self-respect; and no one can deprive him of the dignity of manhood. And that, since man was made to work, is the "Dignity of Labor."

Pope acted his part as the smooth and methodical rhymester, who managed Pegasus as with a patent bit; and while he could not and would not check all his fire, he trotted him along at a serviceable pace. The finished work of the poet of Twickenham is welcomed as a relief in these days of jerky utterances, which the writers cannot spare the time to reduce into readable English.

> "Honor and shame from no condition rise;
> Act well your part—there all the honor lies."

In finished and thorough work lies the true dignity of labor. To-day, taking the reports of our consular agents and the admission of foreign authorities, the American inventors, manufacturers, and machinists stand in the honor of the first rank; and the superiority of American articles exalts them by fair competition. The work of our new country takes the lead of markets where long experience had caused the idea of rivalry to be regarded as an absurdity. The reason is obvious. Once the manufacturers and workmen who now bewail their decline held their place by the dignity—that is to say, the worthiness—of their work. In some lines, though not in all, various causes operating to produce the result, a descent has been made by old work-

GUN COTTON.

THE official report sent in by Colonel Maitland on the present Turkish equipment notices that the Turkish cavalry are totally unprovided with any means for the destruction of bridges, fences, or other obstacles; adding, what might be expected to follow, namely, that the Russians, during the late war, were never detained by the destruction of a single bridge. Until recently, our cavalry had no recognized provision made for this description of work, but there now exists an equipment of gun cotton disks and primers of a simple and suitable character. Two tin cylinders are issued about 2ft. long, which are carried in special wallets, each cavalry soldier carrying one on each side. One cylinder contains about 22 one oz. disks of cotton, the other contains detonating primers and Bickford's fuse for the ignition of the charges. The cotton disks should be dry, because wet gun cotton requires a specially strong detonator to explode it. The method of using the gun cotton is as follows: A sufficient number of disks are taken out and placed touching, or nearly touching, one another against the object which it is wished to destroy. A 20 dram detonator with its quick match is now inserted into the perforation of one of the disks, and the quick match or Bickford's fuse ignited. The length of this is sufficient to occupy about 40 seconds in burning down to the detonator. The man who has lit the fuse has, therefore, abundant time to get away, if no accident interferes with his movements, but he would probably be safer in having his horse led to a little distance than in mounting it close to the burning fuse. The disks are dry. Should the main store of gun cotton at any time get wet, it would be necessary to issue a certain proportion of dry disks for purposes of ignition, for although wet gun cotton may be detonated, and has fully the explosive force of dry cotton, it requires either a very powerful detonator or a dry disk of cotton to fire it. Curiously enough, there appears to be no sealed pattern appliance for igniting the Bickford fuse. The "Laboratory Notes" suggest the use of a vesuvian, and there is no doubt that this is sufficient for the purpose, but it is not our usual habit to depend on means of this "Bohemian" character. The equipment, with this curious exception, is very convenient and efficient. It is probable, however, that men will look a little doubtfully at the proposal to carry so much detonating matter, to say nothing of the gun cotton, on their saddles. The latter is harmless enough, and a few experiments would exhibit its character sufficiently to win the confidence that is desirable in those who have to deal with it. If, for example, a disk be lit by hand by an ordinary vesuvian, it will be seen that when ignited by flame it burns without explosion, if unconfined. When wet, it cannot by any means be exploded by heat, but a sufficient detonation will effect this—possibly that of 100 grains of detonating composition. The men's service detonators contain twenty only, and must be inserted in a dry disk—about two or three dry disks would be sufficient—to start the action in wet cotton. A curious test is exhibited in the laboratory to men under instruction, of the non-liability to ignition of damp cotton by ordinary flame. A slab which has been soaked in water sufficiently to saturate the interior portion to a depth of perhaps ¼in. is cut in half, and the dry interior lit by a match. The interior dry portion burns furiously away, eventually dying out, and leaving the exterior damp shell so completely unburnt that after the process has been performed on each half the two can be put together so as to re-form the original slab in a hollow condition. The safety of wet cotton is thus indubitable, but dry cotton is nearly equally safe, for there is no evil in its liability to ignition, carried as it is in closed tin cylinders, and dry cotton is certainly more readily available for action. As to the detonators, safety with them depends on the method of carrying them. As they are held in grooves in wood, they appear to be safe. The only contingency that would be awkward would be the sudden crushing of the cylinder containing the detonators. A bullet, for example, if it passed through the cylinder in such a way as to strike a detonator, would unquestionably cause a nasty explosion and injure the horse severely, perhaps the man also; but this is as improbable a contingency as that of a bullet striking any other equally small mark, say, for example, the rider's brains, so that it may practically be disregarded.

To come to the capabilities of the gun cotton disks issued in this form. For the communication of detonation it is necessary that the disks should be nearly touching each other. Large disks and slabs may have spaces up to an inch wide between them. It is safer with these small ones to put them as nearly in contact as possible. As to the quantity necessary to produce any given effect, an 18in. brick wall can be destroyed by the application of 1¼ lb. of cotton per foot run. A line of balks, each 12in. square, was cut level with the ground by the detonation of a 1 lb. disk and 10 half lb. disks per balk. It would exhaust a considerable quantity of the cavalry supply to undertake much work on this scale, but it would of course often be well worth while to do so in order to destroy a bridge.

It is sometimes desirable to disable captured or other guns which are likely to fall into the enemy's hands; for this gun cotton is especially suitable. Suppose that the operation has to be hastily executed in the field, it may readily be effected in the following way:

Place 1 lb. of cotton, whether in a slab or in disks, on the gun near the muzzle, as shown in Fig. 1, tying it on sufficiently to hold it in its place. Insert the detonating primer, turning the fuse end to leeward to prevent the flame of the burning fuse by any means reaching the cotton, and so generating *ignition* instead of *detonation*. The fuse, on being lit, burns forty seconds, and the cotton detonates, forcing in the bore of the gun to a sufficient extent to make loading impossible. Should it be desired to destroy a gun in a station when time and means are available, the work is much more completely performed by either sinking the gun, muzzle upwards, in a pit, or else elevating it as much as conveniently may be. Then 2 lbs. of gun cotton and a detonator, with an electric wire system of ignition, are put into a waterproof bag, and pressed to the bottom of bore of the gun, which is filled, or partially filled up with water. The charge is then fired by electricity, when the rigid transmission of force by the water causes the gun to bulge or crack severely, or even to burst altogether asunder, as shown in Fig. 2, which represents a 9-pounder gun acted on by 2 lbs. of gun cotton exploded in this way.

Gun cotton, then, has come into our service equipment for the work of demolition of *matériel* in the field. It seems likely to be used also in rockets. Our war rockets have for many years had their heads plugged up with wood. This, as was often pointed out, was a strange thing; for a charge of powder would certainly have been better than nothing. A charge of gun cotton is, of course, a very much more powerful explosive agent. This is now being tried on a large scale. A 6in. rocket has been made in the laboratory, weighing about 100 lbs., and containing in the head 13 lbs. of damp gun cotton, with a fuse bedded in a dry cotton primer, causing the detonation of the cotton on impact. The action of this against a building ought to be very powerful, the 13 lbs. of detonating cotton corresponding to 52 lbs. of powder strongly confined. Gun cotton has been experimentally tried as a bursting charge for a common or Palliser shell; but the shock which falls on a shell at the moment of discharge is a much greater source of danger than is to be found with a rocket, which only moves gradually forward.—*The Engineer.*

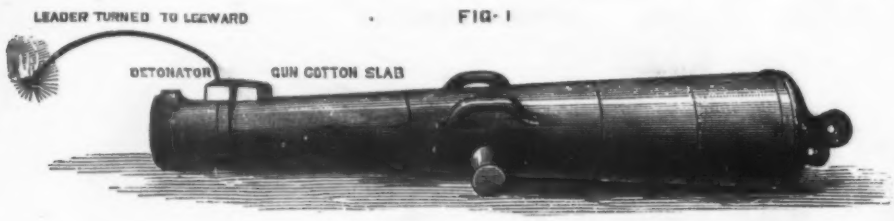


FIG. 1

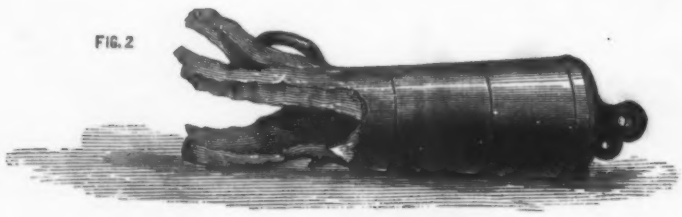


FIG. 2

EFFECTS OF GUN COTTON ON CANNON.

THE WONDERFUL RAILWAYS OF PERU.

DR. HEATH writes as follows in the *Railway Age:*

The reputation gained by the late Henry Meiggs through his extensive contracts with the Government of Peru for the construction of railways, of which less than 1,100 miles cost more than $118,000,000, and the prominence in South American history of this young republic, will make a short article on Peru and her railroads interesting to the general reader, as well as to railway men. Leaving New York city in one of the tri-monthly steamers of the Pacific Mail, or one of the steamers of the Atlas line, you are landed in nine days at Aspinwall—called Colon in South America. From Aspinwall to Panama, forty-seven miles of railroad. Trains leave each way at 7 A.M. and 1 P.M., arriving at 11 A.M. and 5 P.M. The Pacific Steam Navigation Company runs a weekly line of steamers from Panama to Callao in six days, with stoppages at Guayaquil, in Ecuador, and Payta; and also a steamer the 25th of each month from Panama, touching at many points, and arriving at Callao in sixteen days. Besides these, a line from Callao to Valparaiso semi-weekly, time, nine days; a line from Callao to ports on the coast as far north as Eten, semi-weekly, time, three days; a bi-monthly line to Europe, *via* Straits of Magellan, and daily coasters north and south to ports near Callao. Modern Peru occupies geographically that part of South America between 3½ deg. and 22 deg. sout'h latitude and 65 deg. and 81½ deg. longitude west of Greenwich. Its eastern portion, nearly an unknown, impenetrable forest, with rosewood, mahogany, calisaya, rubber trees, coffee, cocoa, coca bushes. It is drained by the principal sources of the Amazon. Its center is a double chain of mountains, whose peaks penetrate many thousand feet the eternal frost, separated by a plateau 9,000 ft. to 12,000ft. above the sea, which, with the less elevated summits, gives abundant pasturage to herds of cattle, horses, sheep, llamas, alpacas, vicunas, and yields good crops of wheat, rye, oats, barley, and potatoes; also rich veins of silver, copper, iron, quicksilver (cinnabar), coal, zinc, gypsum, and various nitrates of soda and potash. Its western portion, a gradually ascending plain from the ocean to the base of the mountains, is an almost barren desert from want of water, a depository of petroleum, salt, nitrate of soda, and guano; but when irrigated, yields the finest tropical fruits, all kinds of vegetables, with rice, sugar cane, and coffee, and the cotton and castor oil plants become perennial trees of 12ft. to 25ft. high, with trunks 2in. to 5in. in diameter. While western Peru, rainless, gives 86 deg. maximum temperature for midsummer, and 58½ deg. minimum for midwinter, eastern Peru gives a tropical heat with rains and vegetation, and its center portion has a climate similar to the United States between the 35th and 40th parallels of latitude. The air coming from the Atlantic passes over Brazil, absorbing the moisture from the mighty Amazon and its tributaries, ascends the Andes, there depositing it in rain, hail, and snow, passes westward one hundred to one hundred and fifty miles, and again falls to the level of the sea. A part then returns eastward over the cool waters of the Pacific, absorbing little moisture, reaches the land, equalizes the temperature, is sucked up the western slope to the summit of the mountains, and, meeting the westward current, is again driven to the sea, thus making the constant southwest wind of Peru, and clear weather. The sea at high tide washes up quantities of fine sand on the beach, which dries at low tide, and is driven inland by the wind, and fills up ravines even to 300ft. of depth and one mile across, banking up behind every protecting surface, and in its passage over the barren plains accumulates in crescent shaped, constantly moving dunes. The shifting sand and barrenness of the country, with the many ravines and uncertain streams, would make the construction of railroads along the coast costly, and their maintenance expensive. Formerly, one going to the capital—Lima—had to wait the trading visits, or go on horseback a journey long, tedious, and perilous. The only means of traveling was on beasts or on foot, and yet the passage from the coast to the interior, with but few exceptions, is still the same. Peru wisely appropriated the wealth derived from the sale of her guano and nitrates to opening up her distant provinces. Providing in most cases only the capital, everything had to be imported, even to laborers.

Payta and Piura Railroad.—The most northern railroad is the Payta and Piura, sixty-three miles long, placed under contract with F. Blume, in 1872, at a cost of $1,945,000. Leaving Payta on the level of the sea, it ascends by a side cut the 80ft. bank that here forms the coast, passes nearly north to Colan, turns east up the river Chira to Zullana, then south to Piura, the first city founded in Peru by Francisco Pizarro, in 1531. It is unfinished. A proposition was made to run a branch from Colan north to Tumbez, so as to give greater facility to export the petroleum and fruits from that place, but as yet only words have been expended; 150 miles "up South," across the desert of Sechura and its salt regions, and beyond the Lobos Islands, with their guano, are the Eten and Ferranafe and Pimentel and Chiclayo railroads.

Pimentel and Chiclayo Railroad.—This is a narrow gauge connecting Pimentel with the principal cities; is patronized mostly during the bathing season, Pimentel being almost deserted except at such seasons. Its stations are Chiclayo, Lambayeque, Muchumi, Tucuma, Pisci, Ferranafe. From Chiclayo to Lambayeque, it runs nearly parallel to the Eten and Ferranafe, and both pass through rich rice and sugar cane fields. The average amount of rice raised in Lambayeque alone is from 8,250,000 lbs. to 9,750,000 lbs. yearly, and the estate of Patapo furnishes fifty tons of white sugar daily.

The Eten and Ferranafe Railroad.—Beginning with an iron wharf 2,050ft. long, has, with its branch to Patapo, ten stations; Port of Eten to Eter, 2 miles; to Monsefu, 4; to Chiclayo, 12 (Lambayeque, 19; Ferranafe, 29); Pomalca, 18; Combo, 21; Tuman, 24; Patapo, 31. During the year 1873 it carried 250,000 passengers. Fare per mile, five cents first-class, three cents second class. Forty-five miles further south is the port of Pacasmayo. A wharf 100 ft. less than half a mile long enables the landing of passengers and freight at all times. A Mitchell's skeleton, it is a well made structure similar to that at Eten, only better material and more expensive, costing $800,000. Until these wharves were built, all landing was by means of large launches or rafts of "balsa" logs. The danger was very great, and many lives each year were lost, even though the steamers had many times to make a round trip without landing, or taking on a single passenger or pound of freight.

Pacasmayo, Guadalupe and Magdalena Railroad, contracted for $5,850,000 with Henry Meiggs, has 74 miles of main line, with a branch 16½ miles. The branch passes to the Haciendas, or farms of Talambo and Lurifico, which have 4,000 and 4,800 acres respectively. Lurifico is almost entirely a sugar estate. The sugar mill recently erected there, bought of Mr. Ward, in Philadelphia, at a cost of $200,000, grinds forty car loads of cane per hour, each car carrying two tons. The rollers each weigh 12 tons; there are five miles of copper tubing, 12 defecators, 20 clarifiers, 12 centrifugals of 1,500 revolutions per minute, produces 60 tons of centrifugal white sugar every twenty-four hours, and 150 gallons of rum per hour. The estate has its own railway, 3ft. gauge, and Rogers' locomotives. The main line of the Pacasmayo, Guadalupe and Magdalena passes up the Jequetepeque river and was intended to terminate at Cajamarca, but the great expense caused the line to be divided into two sections, the first only being finished. It runs within three miles of the rich silver mines of Chilete. Its stations are Pacasmayo to San Pedro, 5 miles; Calasnique, 10 (branch San Jose, 12; Chafau, 15½; Talambo, 21, Chepen, 23; Lurifico, 24; Guadalupe, 26½); Tolon, 24; Monte Grande, 35; Santa Clara, 41¼; Llallan, 58; Chilete, 64; La Vina, 74; four miles further to Magdalena, and then zigzag over the mountains 24 miles to Cajamarca. Thence seven days to Chachapoyas, eight days to Moyabamba, and four days on foot to Balsa Puerto brings the traveler to the navigable Amazon. This is the main route to the Eastern Amazonian departments of Peru. Cajamarca is noted in history as the place where Pizarro murdered Atahualpa, the last Inca king, even after having fulfilled his promise of filling the room he was in with gold as high as he could reach. To the archæologist this road presents an open field, especially the deciphering the hieroglyphics on the rocks at Yoenan. A little more than fifty miles south from Pacasmayo—passing the guano island Macabi—is Salavera.

Salavera and Truxillo Railroad, and branches, under contract with T. Larranaga, at a cost of $3,400,000, a narrow gauge road passes through Truxillo, and crosses the valley of Chicama to Paijan and Ascope, eighty-five miles. It runs only to the best estates, and is a well paying road, now owned and controlled by private parties. At Truxillo there are some of the most noted and extensive ruins of Incal cities. Leaving Salavera and steering south, you pass the guano island Guanape, the port of Santa, and anchor in the beautiful bay of Chimbote. From this point the

Chimbote, Huaraz and Recuai Railroad takes its start, a narrow gauge, 172 miles long. Crossing the Pampa and Old Inca road, it passes the estates where extensive cactus fields give life and food to millions of cochineal bugs, up the Santa river, the sugar estate Puente or Palo Leco, where a twin sugar mill to Lurifico was placed at the same time and by the same party, James Cahill. Continuing up the bank of the stream, it runs by extensive coal fields. About eighty miles are finished. The water of the river is so black and turbid that a system of double tanks is

necessary, so as to let the water settle before running it into the tanks for the engines. The road was contracted by Henry Meiggs, for $24,000,000, Nov. 6, 1871. Its highest altitude is 11,040ft. We now pass southward to Callao. Running from this city north along the coast, partly by side cuttings in the sand banks that form the shore of the Pacific, is the

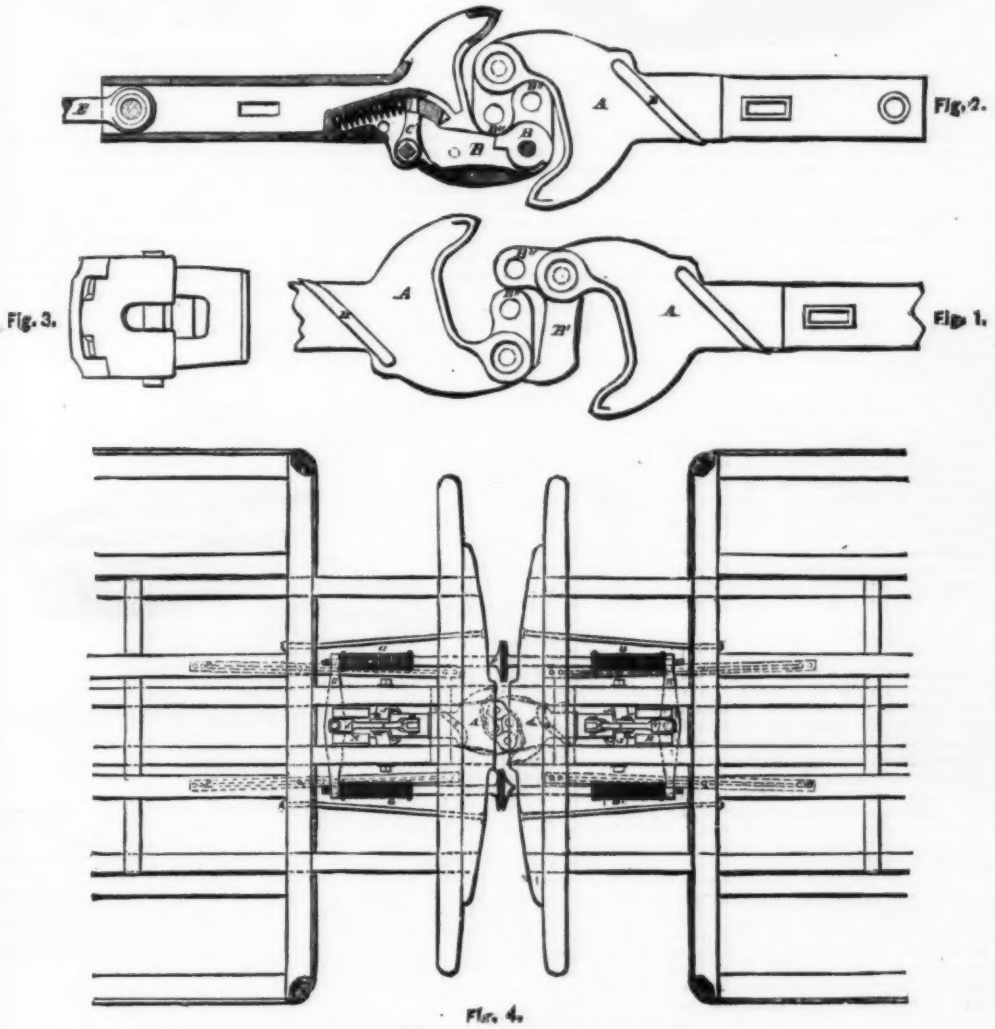
Lima, Ancon and Chancay Railroad.—Bought by the Government of private parties, at a cost of $1,300,000, it was completed forty-three miles to Chancay, costing in all $2,600,000. It was intended to extend to Huacho, but the great cost of keeping it in order, owing to the drifting sand, caused it to stop where it now is.

Chancay and Palpa.—At Ancon many mummies were found. From Chancay a narrow gauge road runs to Palpa, six miles. Ancon and Chancay are both favorite summer bathing places.

THE JANNEY CAR-COUPLER.

LARGE sums of money and a great amount of time have been spent in endeavors to devise a perfect system of connecting the cars of passenger railway trains, but the requirements are so numerous, and the difficulties to be overcome so great, that much the larger number of the efforts in this direction have proved failures.

The car-coupler invented by Mr. Janney, together with his automatic and double-acting compressing device, as applied to equalizing side-buffers, as shown in the accompanying figure, constitute a most complete system for this purpose, and one which is meeting with much favor with some of our leading railroads.



THE JANNEY CAR-COUPLER.

Fig. 1 is a top view of two couplers, represented as approaching each other for coupling.

In fig. 2 two couplers are united; one in section, to show the internal arrangement of the parts.

Fig. 3 represents the knuckle, B, which, when in proper position, serves to hold the two couplers together.

Fig. 4 represents a plan of the platform, with the coupler, compressing device, and side-buffers attached.

The knuckle, B, represents a pinion with two teeth, B' and B" (the other teeth of the series being dispensed with), and the drawhead, A, and tooth or nose, B", of the other coupler representing the rack. When the couplers are forced together, the teeth engage each other, the hub revolves, and the long tooth, B', is carried around into a locking position; the catch, C, being forced back by the circular end of the tooth, B', in passing, after which the catch is returned to its locking position by the catch-spring.

The action in coupling is similar to a pinion, being revolved by the rack, or, when both knuckles are thrown open, to two pinions passing each other and turning on their axes.

The uncoupling is effected by throwing over the platform lever, which in turn forces around the coupler-lever, D, Fig. 2, and catch, C, back, so as to allow the tooth, B', to revolve outward.

It will be observed that the two couplers, when united, form a perfect and closely-fitting knuckle-joint, and therefore give perfect freedom in curving, without either lateral or longitudinal lost motion. It will also be noticed that the guard-arms extend beyond the head of the opposite coupler, and thus absolutely prevent accidental uncoupling; while, from their shape, they serve to guide the parts into coupling position as they approach each other.

The buffers are attached at their rear ends to an equalizing bar, which makes the compression on each buffer-head equal under all circumstances.

The equalizing-bar, H, is pivoted at its center, to the clevis, I, which in turn is pivoted to the yoke-lever, J, and the yoke-lever connected to the horn, L, by means of the clevis, K. The yoke-lever is pivoted midway between the pivot point of clevis, I, and its point of contact with the lower end of horn, L, below the coupler; hence its movement must be in the arc of a circle. It will be seen that the clevis, I, is pivoted at almost double the distance from the yoke-lever pivot point as the clevis, K, and therefore, in a forward movement, would travel nearly twice the distance.

The object of this combination is to increase the compression on each buffer-head as the cars move from their normal position in either direction, and to keep them in close contact, under all circumstances, without the use of heavy buffer-springs, or extending the buffers out so far before a coupling is effected, both of which methods are objectionable, and do not accomplish the object sought. The operation is as follows:

The buffer-heads stand out, before a coupling is effected, about 1 inch beyond the inside face of the coupler-knuckle, and have to be forced back to that distance to make the coupling, which requires about 1,000 lbs. pressure on each buffer-head.

When the train is started, the coupler-draught springs, O and N, yield, allowing the coupler to be drawn out, and with it, by means of the intermediate connection heretofore described, the equalizer, but at an increased motion over the coupler in proportion to the difference in the distance between the pivot points of clevises, I and K, from the pivot center of the yoke-lever, which increase is provided for by the compression of the buffer-springs, G.

It will be understood, therefore, that if the compression at the start is equal to 1 inch, and the movement of the equalizer over the coupler is at the rate of nearly 2 to 1, when the coupler has traveled 2 in., the equalizer will have traveled nearly 4 in., thereby increasing the compression on the buffer-springs, G, 2 in., making 3 in. in all.

The same is true in buffing, except that the increase is more rapid. The platforms being about 2¼ in. apart, there can only be a movement on the part of each 1¼ in. before they touch. In this movement the buffers are forced back on the springs, G, to that extent, which, in addition to the first inch gained in coupling up, makes 2¼ in. While this movement is going on, however, the lower end of the horn, L, being firmly mortised into the coupler and moving with the same, has, by its contact with the yoke-lever, rocked the same on its pivot, throwing forward the equalizer 1¼ in., thus producing in all about 3 in. compression by the time the platforms have touched. In addition to this resistance, the object of which is to prevent the butting of the platforms except in case of collision, the spring, N, which acts in the two-fold capacity of buffer and draught, is shortened, so as to limit its movement to 1¼ in., and enable its full resisting power to be utilized in this movement.

To overcome the increased difficulty in starting trains, caused by shortening said spring, another and lighter spring, O, is added, which, when the draught is applied, yields first.

By this arrangement the inertia in starting heavy trains is much more easily overcome than by the ordinary 8 in. draught springs.

The brace is designed to sustain the platform, and is admirably adapted for this purpose.

The construction of the intermediate mechanism is such that no amount of pressure upon the buffer-heads produces any counteraction of the draught springs, O and N.

Some of the advantages of this improvement have been referred to in the foregoing description, but there are others which deserve special mention.

It is claimed for this device, that by its use telescoping is more effectually prevented than by the use of any other, and for the following reasons:

In addition to the platforms being elevated to a line with the sills of the car-bed, they are brought and kept in closer contact, making of the entire train one elastic structure. Besides, the couplers being closely interlocked, and acting constantly so as to sustain each other against lateral movement, the platforms are prevented from sliding by each other or buckling, as is the tendency in collisions. Practical demonstration has been had of this in several collisions that have occurred, and where no damage or injury was sustained.

Another advantage possessed by this improvement (the absence of which would have been fatal to its adoption by the roads now using it) is that under no circumstances, it is believed, can the train part accidentally. Experiments were made to test this fact in the following manner. The two rails of the track were cut and elevated about two feet above the track level (triangular blocks of equal sides being used to aid the wheels in mounting and descending), and the train run back and forth over the obstruction a number of times, without parting or any injury resulting.

An accident occurred to a train of five cars running at the rate of fifty miles per hour, in which the truth of the foregoing was fully established. The middle car in the train, in passing a curve, was thrown from the track and toppled over to an angle of nearly 45°, and was held by the coupler in this condition until the train could be stopped, when it was found that the body bolts and axles were bent, but this car with its fifty passengers, as well as the whole train, was saved from complete destruction by this improvement, which was found still to be in perfect condition.

The reasons for this will be understood when it is noticed that the coupler of one car extends, and always remains, under the opposite platform, and *vice versa;* consequently neither platform can fall below the coupler of the opposite car.

Still another advantage is that by the peculiar construction of the coupler, being a closely-fitting joint and without longitudinal or lateral play, the unpleasant oscillation or swinging of the platforms in opposite directions is overcome, thereby adding greatly to the comfort as well as safety in running trains.

There can be no doubt whatever that greater steadiness and smoothness, as well as more perfect security, is obtained by the use of this improvement than has been heretofore.

Its adoption as a whole, by the Pennsylvania Railroad for its main line and all the lines it operates or controls, and by the Pennsylvania Company for its immense system west of Pittsburg, after a thorough and exhaustive test covering a period of nearly four years, is sufficient of itself to indicate its importance and value.—*Journal of the Franklin Institute.*

ON ATWOOD'S MACHINE.

To the Editor of the Scientific American:

In reviewing a recent American edition of a work by a distinguished English physicist, the editor very justly says: "Better not teach a subject than teach errors." I trust he will accept this as an apology for pointing out to him an error in this treatise common to every work I have seen on the subject except "Weinhold's Experimental Physics." The error I refer to is in omitting the part taken by the wheel in an Atwood's machine in calculating the work done by the overweight. Assuming a familiarity with the mechanical details of the apparatus, we suppose the cord (whose weight is neglected) to pass over the wheel, and the two cylinders, P and P', to be in equilibrium. Now, when the overweight (m) is placed upon P', equilibrium is overcome and the whole system is moved by (m). Let us take two points upon the circumference of the wheel, opposite and horizontal, and suppose all the weight of the wheel concentrated in them. Now, to move the mass requires force as well as to move P and P', and if when moved they continued to move vertically, as do P and P', we should have to consider the whole weight of the wheel as a part of the mass moved. Since, however, the velocity of all the particles in the wheel diminishes directly as the radii of the circles in which they revolve, the average velocity of all the matter in the wheel is only half the velocity of any point upon the circumference. The cord, then, in giving its velocity to the circumference only moves the whole wheel with half that velocity. So, since the work is measured by the velocity given a mass in a unit of time, we can only consider one-half of the weight of the wheel as a part of the mass moved by the overweight. It is astonishing that this has not suggested itself to more authors of text books, who are supposed to be teachers, and who must have met with frequent embarrassments in endeavoring to make their experimental conform with their calculated results. The following details may assist in proving the foregoing experimentally. 1st. The pendulum should beat seconds. 2d. The friction on the journals, which may vary from different causes even in the same machine, should be overcome by a small friction weight, placed upon P', and if made of lead, and shaped thus, ○, can be pared down until it is just heavy enough to give P and P' a slow uniform motion after a slight tap is given P. To insure satisfactory results this should be closely attended to, and repeated experiments made, and if P and P' are increased in weight, it should be remembered that the friction increases with the mass moved, and hence the friction weight should be increased. I dwell upon this as due attention to it insures success with a very poorly constructed machine. 3d. The space passed over should be measured from the overweight and not from the cylinder. 4th. The commencement of the vibration of the pendulum or that part of it at which we commence to reckon time should be simultaneous with the commencement of motion in the system, and, finally, the click of the pendulum at the end of any given time should not be distinguishable from that of the overweight upon the ring. If this is not attended to as little as one sixteenth of a second (scarcely noticeable) may cause an error of several inches after some seconds. I suspect that it is in this, and in "some allowance for friction," that many experimenters have tided over their failures. That the above may be evident, I take the following example. Say that the weight of the wheel is 700

grammes, the weight of each cylinder 75 grammes, and the overweight 5 grammes. Hence

$75 + 75 + \frac{75 \times 9}{9} + 5 =$ mass moved, and by a moving force of 5 grammes. The intensity of gravity (g) being 9·8 meters, the accelerating force in this system (f) will be at the end of one second $\frac{5}{155}$ of 9·8 meters, or 0·0970 meter. While, on the contrary, if we neglect the weight of the wheel, the result becomes $\frac{5}{151}$ of 9·8 meters, or 0·3161 meter.

By formula $s = bf + 2$, at the end of four seconds this difference would amount in the total space passed over to the difference between 0·776 meter and 2·5288 meters, or 1·7528 meter.

Powhatan Clarke, M.D.,
Professor Natural Sciences, Baltimore City College.

Note.—*Vide* Ganot's Physics; Petite Traite de Physique de Jamin; Balfour Stewart's Elementary Treatise on Physics; Deschanel's Natural Philosophy. The last gives a problem whose solution is, of course, impossible.

THE HEAT OF THE COMSTOCK MINES.

By Professor John A. Church, E.M., Columbus, O.*

One of the most striking phenomena connected with the mines on the Comstock lode is the extreme heat encountered in the lower levels. This heat is not due to the burning of candles, heat of the men, and decomposition of timbers, all intensified by bad ventilation, as was the case nearer the surface. It proceeds from the rock, which maintains constantly a temperature very much higher than the average of the atmosphere in Nevada. The heat of these mines is a matter of more than usual interest, for they are the only hot ones now worked in the United States, and both in the present temperature encountered and in the increase which is to be expected as greater depths are reached, they appear to surpass any foreign mines of which we have a record.

Hot mines are known also in other countries, as in the tin and copper lodes of Wales, where one of the veins worked by the United Mines is known as the hot lode. It has springs which discharge water at a temperature of 116° Fah., the depth being 220 fathoms, or 1,320 feet. The heat of the air in these workings is given at 100 to 113° Fah. The air is bad, and the heat in the drifts seems to be traceable to defective ventilation rather than to the real necessities of the case. Air is supplied through a small pipe, and is drawn from a place where the temperature is 95° Fah. Under such circumstances it is not surprising to read that in this hot mine the air is hotter than the rock, a state of things which I have never observed in the Comstock. Other mines have been reported to the British Coal Committee as having temperatures of 106° Fah. and thereabouts, but the only positive comparisons that are available at this writing are the following, all from Cornish mines:

Mine.	Depth in feet.	Temperature. Air.	Rock.
Tresaveau	1,584	86°	83° to 85°
Consolidated Mines	1,500	87°	86°
" "	1,722	94°	93°
" "	1,764	94° to 96°	92½° to 93¼°

These high temperatures appear to be partly due to the usual sources of heat in mines, and partly to chemical action in the rock, for the average depth in which the heat rises 1° Fah. from the surface downward varies with the ground. It is given by Mr. W. S. Henwood as follows:

In granite	51 feet.
In slate	37·2 "
In cross veins	40·8 "
In lodes	40·2 "
In tin lodes	40·8 "
In tin and copper lodes	39·6 "
In copper lodes	38·4 "

The copper bearing lodes are, therefore, the hottest, and in Cornwall heated ground is thought to be a good indication of copper, just as hot ground is looked upon in the Comstock mines as a favorable sign of ore.

TEMPERATURE IN THE COMSTOCK MINES.

The rock in the lower levels of the Comstock mines appears to have a pretty uniform temperature of 130° Fah. This was the reading obtained for me on several occasions by Mr. Comstock, foreman of the Ophir mine, and about the same temperature was found by Mr. Perrin, foreman of the Chollar Potosi, Mr. Cosgrove, foreman of the Yellow Jacket (139½° Fah. and 136° Fah.), and by myself in the Crown Point and other mines. These readings were obtained by placing a thermometer in a drill hole immediately after the hole was finished, and leaving it there for periods varying from ten minutes to half an hour. Very little or no difference was discovered between holes which were drilled wet or dry, or if wet, between the holes which were naturally wet, and those which were made so artificially. No doubt there must be some difference due to these varying conditions, but they are so slight as to be completely masked by the steady flow of heat from the rock during the exposure of the thermometer. The holes in which the thermometers were placed were not sunk especially for this work of testing, but were the ordinary drill holes made for the purpose of blasting the rock. They varied, therefore, from about 10 inches to 3 feet in depth. No variations in the height of the thermometer were found to be caused by this difference of depth, and this is also quite reasonable.

Mining on the Comstock proceeds with extraordinary rapidity. The drifts are advanced steadily at the rate of 3, 5, and sometimes even 8 and 10 feet a day, and therefore the ground in which the miners are working is always fresh ground. The low conductivity of minerals to heat forbids the supposition that a rock of 130° Fah. temperature can lose heat sensibly to any depth in the course of twenty-four hours. The shallow holes which were made use of always lay in new ground, and exhibited results which may be accepted with as much confidence as if they were 20 feet or more deep. Very often they were in ground which had been exposed only one or two hours, having been sunk immediately after a blast which threw off 4 or 5 feet of rock. The surface which was thus thrown down had not been exposed more than twenty-four hours. The high temperature and small flow of air in the heading forbid the supposition that any sensible diminution of heat could have taken place at the bottom of the drill hole under such circumstances. The surface of the rock exposed to the air of the drift was found to be 123° Fah., the experiment being made near the "header" or end of the drift. The air itself was found to show considerable uniformity when its temperature was taken under circumstances that were at all similar. In freshly opened ground it varied from 108° to 116° Fah., and higher temperatures are reported at various points, reading, in fact, as high as 133° Fah. in the 1,900 level of the Gould and Curry. The temperature of the air is subject to more fluctuations than that of the rock, for the simple reason that it is artificially supplied to the mine, and varies according to the distance to which it is carried, the quantity, velocity in the pipe, and its initial temperature. All of these elements of the problem vary within wide limits. The initial temperature of the air which supplies a particular drift will, for instance, depend upon whether it is drawn from the surface, the bottom of a shaft, where it is often cooler than above ground, or from some old air-way, where it has had time and opportunity to take up heat. Nevertheless, even under such variable circumstances as these, the temperature of the air in a new drift does not ordinarily vary much more than 8°, and in this variation the length of the drift appears to be the most important factor. This uniformity of temperature, under such changing conditions, is due to the well known fact that the amount of heat absorbed from the walls of a drift or shaft in a mine depends upon the difference in the initial temperature of the air and rock. The greater this difference, the greater is the absorption, but as soon as the temperature of the air current approaches that of the rock, the heat absorption proceeds much more slowly.

In the Comstock mines it is the custom, without exception, to blow the air through galvanized iron pipes, the diameter of which is usually from 8 to 20 inches. The size most used is 11 inches in diameter, and the usual amount of air blown is about 700 cubic feet per minute, this being the supply for two to six or more men, working in one or two "headers." In most cases the air is not sent down from the surface, but taken from some point in the incline or at the bottom of the shaft. Its temperature may be assumed at about 85° to 90° Fahr., in summer, though it is sometimes higher than this. Its velocity in the air pipe is not very far from 1,000 feet per minute. From these data it will be seen that we have about 15° or 20° of heat added to the air, in a period of time varying from one-half minute to two minutes. The iron of the pipe is so thin and its conductivity so great that we practically have a slender current of air moving through a body of hotter air. Even this statement of the case does not exhibit all the opportunities for absorbing heat which are forced upon the air.

The iron receives heat both by immersion in the hot air, and by direct radiation from the still hotter walls. The currents confined in it must be thrown against its sides by eddies, and the air is thus made to absorb heat by contact as well as by the transmission of heat rays through it. It is probably to this cause that the uniformity of the air temperatures obtained at the headers may be attributed. They depend almost entirely on the heat of the ground there and very little upon the temperature of the air at the point of supply. Drifts that do not exceed 200 or 300 feet in length are usually not above 110° or 112° Fah. in temperature and more often they are below this. But when the length increases to 1,200 and 1,500 feet the temperature may rise to 116° Fah., without any other change in the circumstances. So far as my personal experience goes, the latter temperature has not been exceeded in any drift into which a good current of air is blown. By a "good current," I mean one of not less than 700 or 1,000 cubic feet per minute. Still there is no hesitation in asserting my confidence in the higher temperatures which others have sometimes obtained. The view which I take of the phenomenon and its cause admits of such exceptional heat at particular points as a rational consequence of the forces at work. But I regard them as exceptional, and believe the average temperature of those drifts which are considered to be distinctively "hot," is usually not above 108° to 112° Fah., though rising 116° Fah., when they are very long. These limits are, however, not in the least degree true of the water which enters the drifts from the country rock, and also from the lode rocks. That approaches more nearly 150° Fah. The vast body of water which has filled the Savage and Hale and Norcross mines for more than a year, and from which it is safe to say a million tons of water have been pumped within twelve months, gave me a temperature of 154° Fah. Even after being pumped to the surface through an iron pipe exposed, in the shaft of the Hale and Norcross, to a descending current of fresh air for more than a thousand feet, and then flowing for one or two hundred feet through an open sluice in a drain tunnel which discharges into a measuring box, the water in this box was found to have a temperature of not less than 145° Fah. But the water varies in temperature in different parts of the lode, like the rock and the air. In the east crosscut, 2,000 foot level, of the Crown Point Mine, which is noted for its extreme heat, the water, after flowing for nearly one hundred and fifty feet over the bottom of the drift, was found to have a temperature of 157° Fah. On the contrary, in other places the water is much less hot, but I believe it is as a rule always hotter than the air, and in many cases it appears to be hotter than the rock is found to be, except in especially hot spots.

* Read at the Chattanooga meeting, 1878, by permission of Lieut. Geo. M. Wheeler, Corps of Engineers, U.S.A., in charge of United States Geographical and Geological Surveys, west of the 100th meridian.

Dr. Holz has found that the specific magnetism of magnetic iron-stone is the greatest of all magnetic substances hitherto examined. Its maximum permanent magnetism is nearly as great as and partly greater than steel, as hard as glass, and its permanent magnetization is sooner removed in demagnetization, with the same external agencies, than that of steel.

NOTES ON THE MICROSCOPICAL EXAMINATION OF IRON.

From a Report, by A. Martens, to the Society of German Engineers.

This paper is merely intended to direct the attention of all those interested to the microscopical examination of iron, and to demonstrate its practicability in regard to the determination of the comparative value of the different kinds of that metal.

I have so far applied the microscope to newly fractured surfaces without special preparation, to polished surfaces, and to the latter exposed to the action of different chemical reagents.

Generally, the objects need only to be moderately magnified; magnified too much, the light is dispersed, and the views cease to be clear and comprehensive.

Fig. 1 *a*.—GRAPHITE FROM LANGLOAN IRON, OBTAINED BY SOLUTION IN MURIATIC ACID. Prop. 50 : 1.

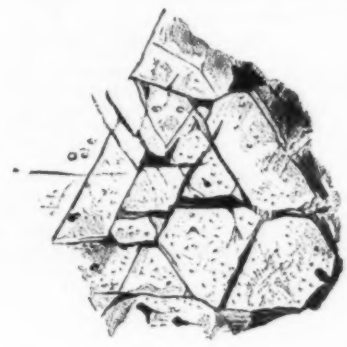


Fig. 1 *b*.—PART OF 1 *a*. 250 : 1.

In the observation of fractures, our attention is first called to the particles of carbon or graphite, which are, as in dark gray cast iron, sometimes so numerous that the iron itself is completely hidden from view. Fig. 1 *a* represents a single particle of graphite, as seen in reflected light. It shows numerous fissures running in different directions. Fig. 1 *b*, a portion of this particle, shows that it consists of numerous, generally triangular scales, superposed upon each other like those of glimmer. Its appearance is identical with that of small particles of ordinary graphite,

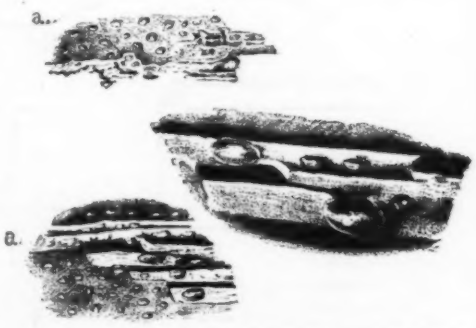


Fig. 2.—SURFACES OF FRACTURED SPIEGELEISEN.

and thus the presence and condition of carbon in iron is microscopically demonstrated.

Next we observe the different compounds of iron and other elements, and such admixtures as silicium. They are best seen in iron poor in carbon; in that case the general appearance of iron is changed equally as much under the microscope as when viewed by the naked eye. The elevations or "grains" are then of a bluish, often silverish luster, entirely different from the fatty appearance of the graphite. Besides, the varying position of the scales of the latter to the light causes some of them to appear entirely black, while the edges form sharply defined, light lines.

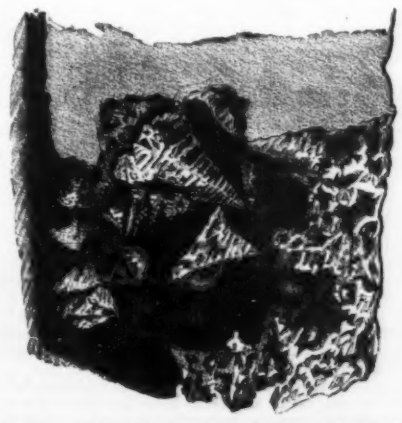


Fig. 3.—CAVITY FILLED WITH CRYSTAL, NATURAL SIZE.

The appearance of spiegeleisen is quite characteristic. The surface is partially quite even, showing in some portions a high degree of polish. Other parts are covered with masses of rectangular columns or bars, as indicated in Fig. 2 *a* and *b*. These bars are placed in parallel directions, and are, as also portions of the surrounding surface, covered by minute globules, of which a square inch would be capable of taking up over 800,000.

Of considerable interest are the crystals found in gray cast

iron, and represented by Fig. 3. The individuals composing the crystals, which incline to the octahedral form, are of the structure shown by Fig. 4, similar to a branch of a pine tree. When these crystals are found in cavities, they shine in the most beautiful colors, similar to those acquired by steel and copper through heat, only more intense. In ordinary gray iron I did not observe them except when filing out partially such hollow spaces; only in gray charcoal iron I was able to discover them inclosed in the solid mass. In that case they were generally much elongated. I have been led to believe that, from the presence of these crystals in the

FIG. 4.—PINE-TREE-SHAPED CRYSTAL, 80 : 1.

solid mass, and the degree to which they deviate from their normal shape, conclusions may be drawn to the quality of the iron.

Single crystals of iron, as represented by Fig. 5 *a* and 5 *b*, are rarely met with. It has so far been impossible to examine them in regard to their chemical composition on account of their smallness, the one in question being only 0.0078 of an inch in diameter.

When observations are to be made on polished surfaces, the latter must be prepared with the utmost care. It requires some patience and experience to produce a polished surface as it is required for this purpose. I generally file down small pieces till they are very thin, and then cement them on a piece of wood. Next I grind down further on a piece of plate glass with emery flour and water. The same operation is repeated on a second plate. The last polish is given to them on a third plate by means of oxide of tin, the very finest emery and water. The emery used for the last operation I gain from the material used in the previous ones, by allowing to settle and separating the coarser portions and only using that portion remaining in suspension in the water longest.

It is best to apply a magnifying power of about 200. If possible, the object should be placed in oblique position, so as to cause the light reflected from the polished surface to be thrown into the area of observation.

Gray iron, when rich in carbon, presents on surfaces thus polished numerous cracks, crevices, and depressions of various shape. Portions of such surfaces are represented by Figs. 6 and 7. Some are even perceptible to the naked eye. They are probably caused by the particles of graphite being crushed and carried away by the process of grinding. The

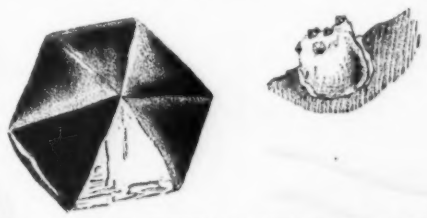


FIG. 5 *a*.—IRON CRYSTAL, SITTING ON GLOBULE, 180 : 1.

FIG. 5 *b*.—GLOBULE CARRYING CRYSTALS OF IRON.

color of the surfaces varies with the quality of the iron; this is probably caused by the different colors of the chemical combinations predominating in the iron.

Spiegeleisen, when polished, also shows a different appearance under the microscope. It shows distinctly where the solid iron is traversed by scales of graphite, and numerous crevices are noticed. Fig 8 shows a polished piece of spiegeleisen.

The microscopic appearance of iron becomes, however, much more distinct and comprehensive, when the polished surfaces are treated with various chemicals. I use salts and acids, such as sulphuric and muriatic acids. The chemicals must be always largely diluted. Of acids I form a dilution of 1:9, in alcohol, and of this dilution I use two drops to the ounce of water for preparing the etching fluid. To the latter the surfaces are exposed several days, during which they must be brushed occasionally.

Pure iron is less affected by acids than iron containing large quantities of other substances; spiegeleisen is acted upon after the lapse of some time, and, when a surface is partially only formed by it, its outlines are sharply defined from the soft, dark, and more affected surroundings.

Sometimes spiegeleisen appears to be covered all over its surface with small holes, the relative position of which indicates the existence of a law by which their location is determined. They often are in such close proximity to each other, that it looks as if they were connected to pairs and triplets. They form parallel rows, as shown in Fig. 9.

By using chemical agents of different character the different constituents of iron may be singly brought into view. Or, they may be seen simultaneously, when, by warming, different colors are imparted to them.

The fact that even the iron crystals of pine tree shape are not *pure* iron has been proven by dissolving such a crystal, shown in Fig. 10, in sulphuric acid, when a small quantity of graphite was left behind, although none could be detected by the microscope.

In consideration of these facts it must be clear that the different constituents of iron are only mechanically mixed with that metal, but arranged in position with astonishing regularity. Therefore microscopical examination must yet become of the greatest practical value, although extensive studies will be necessary to accomplish this end.

CHICAGO CLAIMS THE NEXT WORLD'S FAIR.

THE Chicago *Journal of Commerce* asserts that not only should Chicago have the next world's fair, but should have it in 1882. It says:

"Why we should be at all delicate about pressing our superior attractions and advantages upon the attention of our own people and those of other nations does not appear. We surely possess every necessary facility for presenting as good an exposition of the world's productions as any other locality on the face of the earth. So far as the United States are concerned, we are preëminently better qualified for so momentous an enterprise than any seaboard or other inland city. We are the very focus of American industry, and can draw hither all the mechanical effects and agricultural and mechanical productions of the country, and of the neighboring Republics and States, in less time and at much less expense than at our sister cities.

Of the eight international exhibitions that have thus far been held, Europe has had six, America only two. The *Journal* insists it should be our turn next, and that it should not be delayed beyond 1882. Of those that hold that the date named would be too early, the *Journal* says:

"They do not, apparently, believe that international fairs should be instituted more than once in ten years. Yet why not? Prior to the inauguration of this system, international commerce increased very slowly. The producers of the different nations were not familiar with the modes, capabilities, or requirements of their neighbors. They were even ignorant, to a great extent, of each other's habits, customs, and language. But what advancement has been made by general intercourse since the Exhibition at London in 1851, when for the first time the nations gathered together to examine the manufactures and products of each other.

FIG. 6.—SURFACE OF FRACTURED CASE-HARDENED IRON, 25 : 1.

FIG. 7.—POLISHED SURFACE OF FRACTURED LANGLOAN IRON, 50 : 1.

FIG. 8.—POLISHED SURFACE OF KENNEIL IRON, ETCHED WITH SULPHATE OF COPPER, 60 : 1.

FIG. 9.—POLISHED SPIEGELEISEN, ETCHED WITH SULPHATE OF MAGNESIUM.

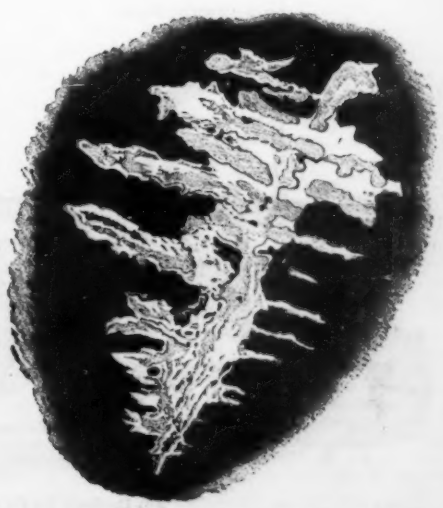


FIG. 10.—PINEAPPLE-SHAPED IRON CRYSTAL, POLISHED, 50 : 1.

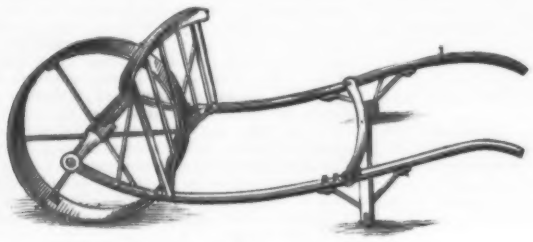


Fig. 1.—Wheelbarrow for Carboys.

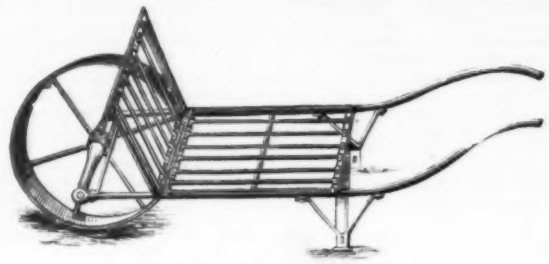


Fig. 2.—Skeleton bed Wheelbarrow.

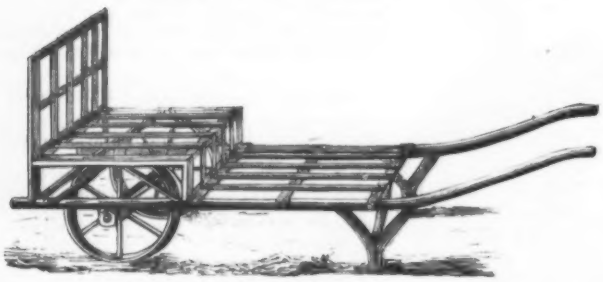


Fig. 3.—Wheelbarrow for Baggage.

Fig. 4.—Wooden Wheelbarrow.

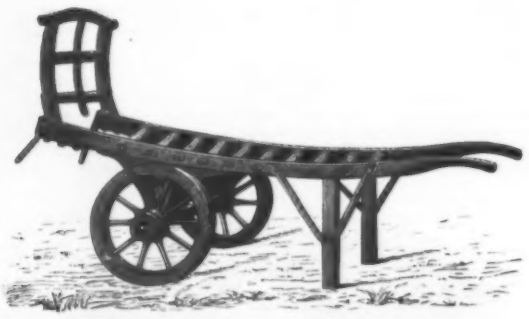


Fig. 5.—Wheelbarrow for Railway Stations.(Model of Orleans.)

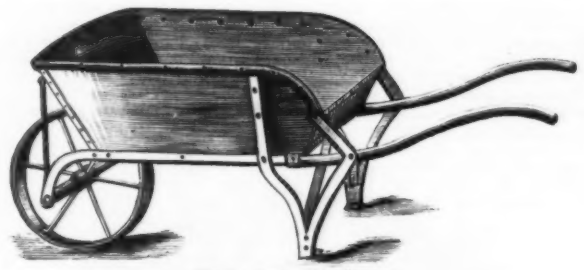


Fig. 6.—Garden Wheelbarrow.

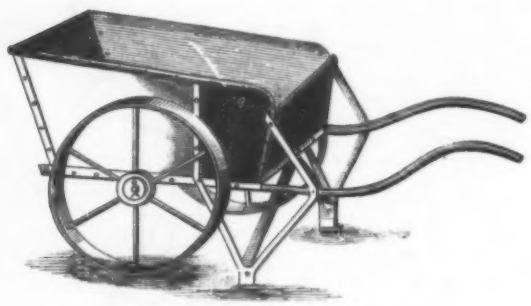


Fig. 7.—Large Box Barrow with Two Wheels.

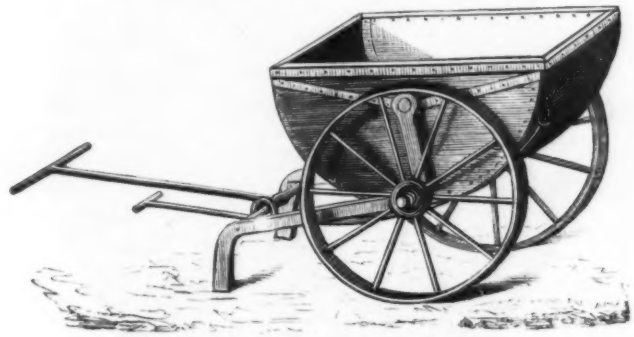


Fig. 8.—Coke Barrow.

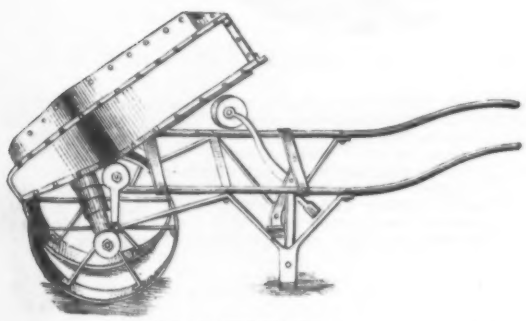


Fig. 9.—Dumping Barrow.

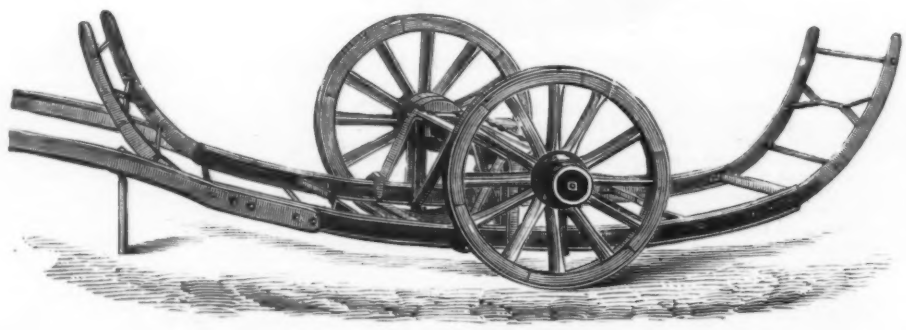


Fig. 10.—Truck for Wood.

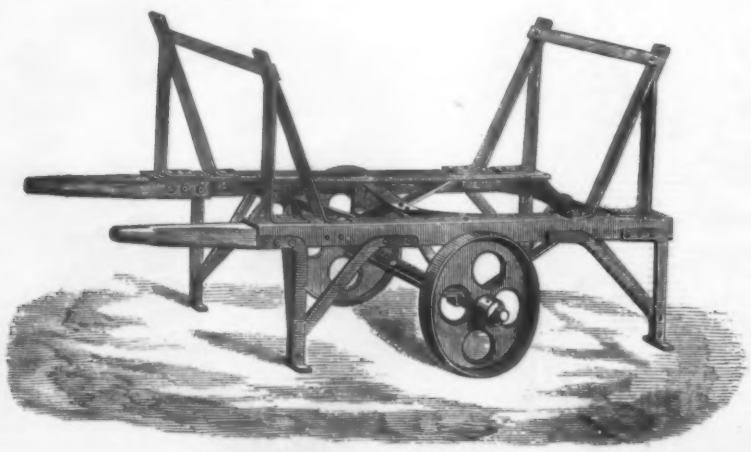


Fig. 11.—Truck for Pig Iron.

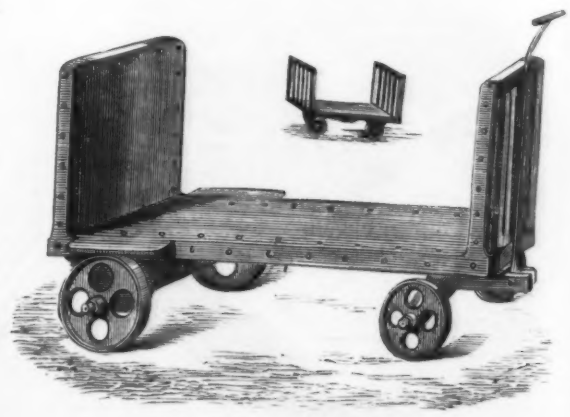


Fig 12.—Baggage Truck. (Eastern Railway.)

FRENCH WHEELBARROWS AT THE PARIS EXPOSITION.

Fig. 13.—Sack Truck. Weight 34 lbs. Price $4.

Fig. 15.—Truck for Stores.

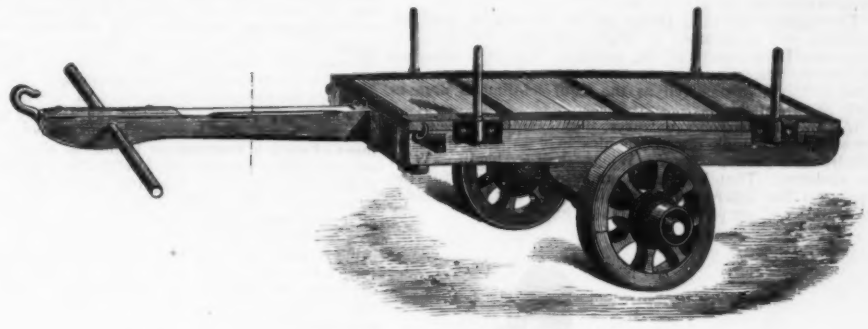


Fig. 16.—Low Truck for Hauling Stone.

Fig. 14.—Bloom Truck. Iron, 10 cents per pound. Wood, 22 to 28 francs.

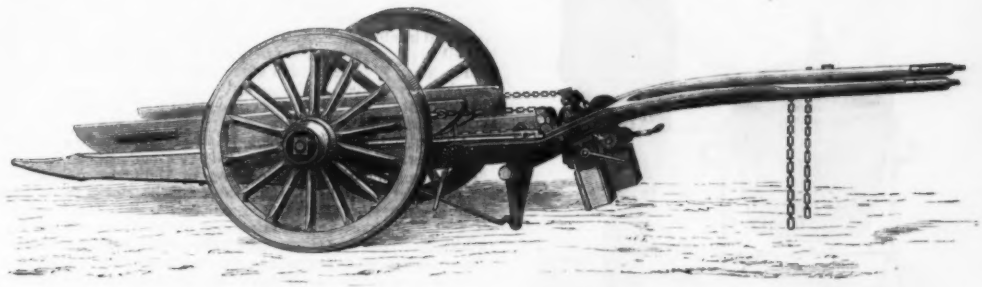


Fig. 17.—Dray with Windlass for Hauling Stone.

Fig. 18.—Bruel's Tub Barrow. Wooden Barrel, 50 francs.

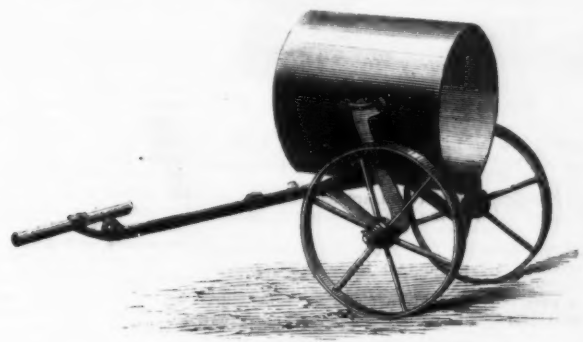


Fig. 19.—Bruel's Tub Barrow. Iron Barrel, 65 francs.

Fig. 21.—Beame's Pump Barrow. Horizontal Action. Capacity 2,500 liters per hour. Complete with Suction and Discharge Pipes, etc. 136 francs. Capacity 5,000 to 6,000 liters per hour, 213 francs.

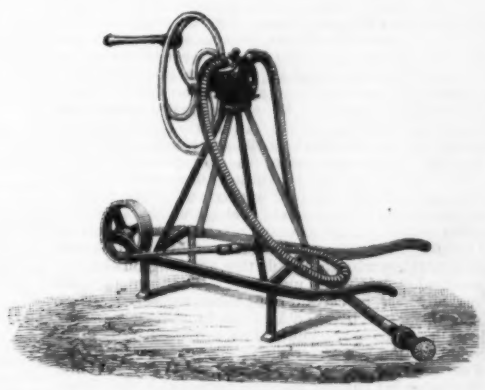


Fig. 24.—Rotary Pump on Iron Frame. Capacity 2,000 to 3,000 liters. Price 160 to 240 francs.

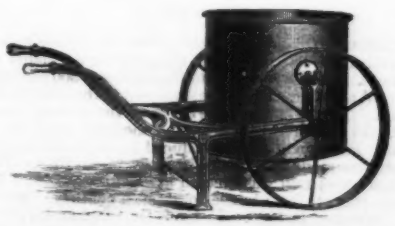


Fig. 20.—Waite, Burnell & Co.'s Swinging Tub Barrow Capacities 82 to 225 liters. Price 75 to 180 francs.

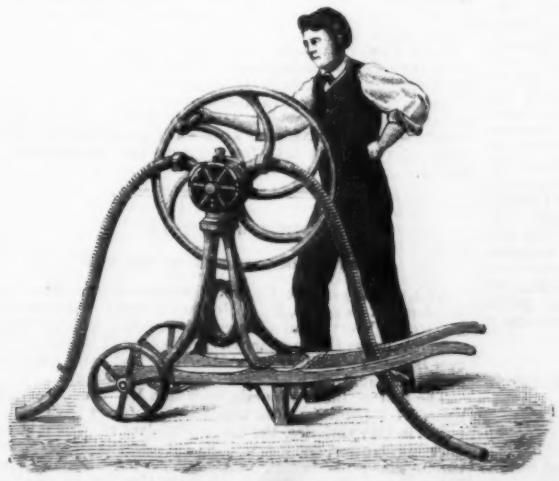


Fig. 23.—Rotary Garden Pump Capacity 2,000 to 9,000 liters per hour. In bronze from 105 to 420 francs.

Fig. 22.—Garden Pump or Barrow. Vertical Action. Price complete 115 francs.

FRENCH WHEELBARROWS AT THE PARIS EXPOSITION.

FRENCH WHEELBARROWS.

IF a man should arrive in France with but limited respect for wheelbarrows, he would be certainly in the way of conversion from the error of his ways.

Throughout the land things go on two wheels, and the voitures and omnibuses of Paris—all four wheeled—are but a small percentage of the totality. The predominance of the two wheeled is not alone with the wheelbarrows, but most of the heavy as well as the light hauling is done in carts of various kinds.

It is in wheelbarrows, however, that I am at present interested, and I think our mechanics may see something to admire and perhaps copy. Where shall we begin? With the skeleton. That is a fair foundation or frame for the subject. The different figures will require but little besides the names and purposes for sufficient explication.

Fig. 25.—Carboy Support.

Figs. 1, 2, and 3 are made by Paupier, are all of iron, and are sold for 1fr. 10c. per kilo, about 10 cents per pound avoirdupois.

Figures 6 and 9, inclusive, are of iron, are made by Paupier, and sold at the same price as the skeleton barrow, 10 cents per pound.

Figs. 10 to 24 will be easily understood from the descriptions which accompany the different forms, and in some cases the prices also are given.

Of Fig 25 it need only be said that the inventor, while abstractedly considering his carboy support, soliloquizes thus:

"It only needs handles and wheels to make a wheelbarrow of it—I think, I think I must add them."

That would make a quarter century of wheelbarrows.

EDWARD H. KNIGHT.

A CO-OPERATIVE MANUFACTURING CITY.

PETER PAPIER is a Frenchman and a philanthropist. For thirty years or more he has dreamed of founding a practical Utopia, and has already made several unsuccessful attempts to put his theories to the test of fact. His last project, as described in a late issue of the *Times*, possesses several uncommonly sensible features, its chief error apparently lying on the side of overpayment of capital. He proposes, in the first place, to establish a co-operative city, for the location of which he has selected and acquired title to the greater portion of one of the most beautiful islands in Port Royal Harbor, S. C., comprising in all about 10,000 acres, and agents are now at work in various sections of the country enlisting in the enterprise factory operatives, skilled laborers of all kinds and conditions, and a few men of science and of the professions; the conditions of membership being that the candidate must be able bodied, under 45 years of age, and of good repute for industry, sobriety, and social morality. It is not proposed to interfere with the family ties, the religious biases, or the political opinions of members. They are to bind themselves, however, by certain obligations respecting industry and morality, and by an obligation to respect the new principle of labor co-operation. The proposed basis upon which compensation is to be regulated embraces the recognition of certain new factors in co-operative industry. While Holyoake cannot get further than the proposition that labor shall employ capital and pay it wages, not capital labor, and takes no notice of managing intelligence in his co-operative scheme, Papier proposes to accept certain well-defined economical facts in his co-operative manufacturing city. Accepting the existence of three forces in the productive industries of modern society, namely, capital, intelligence, and labor, he would make an equitable distribution of interests between them. For example, supposing it to require $200,000 to build and equip a factory, he would regard this sum as entitled to 8 per cent. interest (or wages) in advance of any division of the profits—$16,000 per annum. Supposing, secondly, that it takes 400 skilled operatives to carry on the work, the latter are to receive a given compensation per day at the market prices of labor, say $2 each on the average. Finally, as education and experience are required in the management of such an enterprise, the superintendent must receive a salary of about $5,000 a year, that being the rate of compensation for intelligence of that class. Suppose, after deducting for wear and tear, paying the capital its 8 per cent., the operatives their $500 each, and the manager his $5,000, a balance of $100,000 remains as the net profit, this is to be distributed pro rata according to the value of the services of each factor, thus:

Proportional share to capital, according to services, represented by $16,000	$7,240
Proportional share to intelligence, according to services, represented by $5,000....	2,262
Proportional share to labor, according to services, represented by $200,000 per year paid to 400 operatives	90,498
Total.....	$100,000

This scheme gives to the capital engaged an equitable share in the profits, to intelligence a proper share, at the same time reserving to each operative $226.25 at the end of the year as his equitable proportion. But suppose the enterprise should fail, or at best should involve losses instead of profits, to whom should the capitalist look for compensation; for co-operation in profits involves the idea of co-operation in losses? To meet this contingency, each operative binds himself to lay aside every week a given percentage (say 10 or 15 per cent.) of the payment for his services, so that any losses may be settled pro rata at the end of the year by the capital, labor, and intelligence involved in the concern. The government of such a corporation is not so simple a matter, for supposing that there are 400 stockholders, shares being placed at $25 each, some may own 100 shares, some only one, and so on, but for the holder of 100 to have 100 times the voting efficiency of the holder of one would concentrate the power in a few hands and destroy the co-operative principle. In order to meet this exigency and avoid inequality, the voting power has to have the same basis as that upon which the dividends are made up, each co-operator having one vote on services, and then such additional voting power as the earning capacity of his shares at 8 per cent. is entitled to; that is, in the corporation just outlined, the operatives would have about 350 votes in all by virtue of services, and the remainder would belong to capital and intelligence. To put the distribution more clearly, if the relative services of capital, labor, and intelligence stand in the proportions of 16, 5, and 200, (in all 221), the votes must be fixed at some multiple of the whole sum, say 442, which gives one vote for every $500 in services rendered. Co-operative stores and co-operative banking form the natural complements of co-operation in other departments.

Although this seems visionary, the extraordinary success of co-operation in Germany, based principally upon the wonderful banking system introduced by Delitsche, guarantees its practical feasibility. Something of the statistics of German co-operation 14 years ago will be found in Hon. Abram S. Hewitt's report as Commissioner to the former Paris Exhibition. This report was prepared while German co-operation was still an experiment. There now exist in Germany no less than 3,300 co-operative associations, with 1,000,000 members, owning property, working materials, and capital to the amount of $40,000,000, and producing at the rate of $600,000,000 per year in manufactured articles. It is seen, then, that under favorable circumstances the value of annual products is about 15 times the amount of the capital engaged. This is considerably in advance of the ratio of production to capital in New England manufactories, and directly raises the question of to what extent each man's interest in the result may be influential in fostering economical production—a question as to which the data are as yet too much scattered and slight to admit of satisfactory discussion. Peter Papier would give co-operation an advantage of 20 per cent. as respects this ratio; but Peter Papier is possessed of an idea—the veriest modern equivalent for the demoniac possession of the ancients—and believes, with the late John Stuart Mill, that "co-operation will lead to the regeneration of the popular masses, and through it the whole of society."

The point where M. Papier takes issue with Holyoake is as regards giving capital a share of the profits according to its relative earning capacity in producing them. "When capital has received its interest," says the latter, "its claims are ended, and were capital content with this there would be no conflict with labor." Similarly may capital argue: "When the workingman has received his wages his claims are ended, and were he content with that there would be no conflict." M. Papier thinks the argument is as sound in one case as the other, and has taken a step in advance by imposing the pro rata recognition of both according to the market value of their services. M. Réclus says: "Give the capitalist one-third of the net profits and the worker two-thirds." But this, as Mr. Edwin Hill makes clear, is an arbitrary division not based upon equity.

It being conceded by the most advanced thinkers that trade-unionism has failed, and that strikes and labor émeutes have proved without practical benefit, the new principle of industry (*vide* Mr. Holyoake in the *Nineteenth Century*) has assumed great importance in labor congresses of late. The general tendency in France, as expressed by the recent Labor Congress at Lyons, is to regard unionism as only a stepping-stone to co-operation and to denounce strikes as useless. If they succeed, they merely raise the cost of commodities, and thereby of subsistence, so that the striker has to pay the advance in his own wages, and little more; if they fail, the time and disorganization are a total loss to all parties concerned. The statistics of this country have shown (says M. Papier) that every rise in wages is followed by a more than proportionate rise in the price of articles of subsistence, and hence, that the workingman is ultimately the loser by the forced advance. It is noticeable that at the Lyons Congress Communism and Socialism were alike scouted, while at the Gotha Congress (German) Communism was the dominant idea. Property is not the point of attack in France at present; the cry is for an organization of industry that shall allow the working men to work out their own salvation; for a method of co-operation that shall give the worker an interest in the results of his own productive industry; recognizing capital as equitably entitled to proper remuneration, and as exercising, on the whole, a beneficent influence upon modern society, and managing capacity as equally concerned in the result.

Peter Papier's utopian city—his summer island—represents these latest conceptions of the workingmen of France. He claims to have already enlisted 2,000 persons in his enterprise, with sufficient capital to meet the exigencies of the co-operative colony, which, as an industrial experiment on a large scale—the first of its kind—will be entitled to careful study, for a utopia transformed into fact is no longer a utopia.

NEW MINERALS.

NEW YORK ACADEMY OF SCIENCES.

AT a meeting of the Chemical Section of the New York Academy of Sciences, held Monday evening, January 13th, Dr. Henry Wurtz read a paper on some new and interesting minerals he was so fortunate as to discover in the ores of the new bonanza of Silver Islet Mine that had been submitted to him for analysis.

The first of these minerals, to which Dr. Wurtz gives the name of "Huntilite," in honor of Professor Sterry Hunt, exists in two varieties, the more abundant of which is of a dark gray color, having a dull, granular, amorphous fracture. The other occurs in a gangue of calcite, and has a bright, crystalline cleavage. Notwithstanding so great outward differences, these two varieties fall under one formula when calculated according to the accepted theories of quantivalence. Their composition is as follows:

	Alpha Huntilite (crystallized). Percentage.	Equivalents.	Beta Huntilite (amorphous). Percentage.	Equivalents.
Arsenic	23·99	100	21·10	100
Antimony.....	4·25	11	3·33	10
Mercury.....	1·11	1.5	1·04	2
Sulphur.....	1·81	17·5	·78	8.5
Silver	44·67	129·5	59·00	194·5
Cobalt	7·33	38·5	3·92	23·5
Nickel	2·11	11·5	1·96	12.
Iron	8·53	47·5	3·06	19·5
Zinc	3·05	14·5	2·42	13·5
Combined water	·33		·19	
Silicate gangue.	·55		·88	
Calcite gangue..	1·10		2·35	
	98·83		100·03	

The gangue being deducted, the density of the alpha variety at 0° was 6·27, and that of the beta, 7·47.

The mercury in this mineral sublimates in the metallic form, and is, therefore, present as amalgam, and not as cinnabar. As sulphureted hydrogen is not given off with hydrogen acids, the sulphur present should be computed as pyrites, and not as monosulphide.

Then regarding the cobalt, nickel, iron, and zinc as dyads, or equivalent to double the quantity of Ag′, deducting Hg as Ag'_2Hg'' and S as $Fe''''S''''_2$, we obtain in

	Alpha Huntilite.	Beta Huntilite.
As+Sb.....	111	110
Sum of the other metals by quantivalents.....	332·5	319
Or.....	$As.Ag^{2\cdot99}$	$As.Ag^{2\cdot80}$

Both, therefore, reduce to one compound, strictly normal, according to quantivalence, with As triad: $As'''Ag'_3$. Its analogues in the mineral kingdom are the discrasites ($SbAg_3$ and $SbAg_3$) and the domeykite series:

Domeykite, $AsCu_3$.
Algodonite, $AsCu_6$.
Whiteneyite, $AsCu_9$.

It might, therefore, be viewed as an arsenic-discrasite or a silver-domeykite; but Dr. Wurtz prefers to regard it as the first member of a new homologous series.

The two huntilites are somewhat sectile and malleable, and are easily burnished with a knife blade. It is not surprising, therefore, that specimens had been stored away in several cabinets for some years as "native silver," while those who examined the ores on the spot failed to detect the presence of antimony, mercury, and zinc in them. Professor Hunt himself at first had some doubt as regards Dr. Wurtz's claim of priority, believing that the species dedicated to him had already been described by Thomas Macfarlane, the discoverer of Silver Islet, but his doubt was set at rest by that gentleman himself, who, on seeing the specimen, declared it to be entirely new to him.

It may not be amiss to caution those who desire to verify the analysis of huntilite against the fumes of arseniureted hydrogen given off when it is dissolved in hot dilute sulphuric or hydrochloric acid.

Animikite.—Among the new ores found at Silver Islet are very large quantities of a new mineral, called "native silver" on the spot, but for which Dr. Wurtz proposes the provisional name of animikite, from the Indian name for thunder, being an allusion to Thunder Cape, near Silver Islet. This ore occurs in large isolated slabs and incrustations, of a light grayish color, fine granular structure, and dull, conchoidal fracture. One specimen had a density of 9·45, and was composed as follows:

	Percentage.	Equivalents.
Arsenic	·35	100
Antimony.....	11·18	5
Mercury	·99	5·5
Sulphur.....	1·49	50·5
Silver	77·58	771
Cobalt	2·10	38
Nickel	1·90	35
Iron.....	1·68	32
Zinc.....	·36	5
Gangue	1·68	

Its quantivalent constitution is, therefore, $(Sb.As)_{105}\ M'_{200}$ or very nearly $SbAg_2$, a new homologue of the discrasite family, making the latter parallel with the domeykites: $SbAg_3$, $SbAg_6$, $SbAg_9$.

The discovery of these minerals involves theoretical considerations of a high order, which we reserve for a future communication, premising only that Dr. Wurtz claims it to be the direct fruit of a discovery announced by himself nearly two years ago.

C. F. K.

DR. OTIS JOHNSON, of the University of Michigan, gives the following new test for arsenic: Place the mixture containing arsenious or arsenic compounds in a Marsh apparatus with a concentrated solution of potassic hydrate and a little aluminium wire. Upon warming, arseniureted hydrogen will be evolved, which may be subjected to the usual tests. If, however, the gas blackens argentic nitrate, the proof is quite conclusive, since antimony by this process is not converted into antimoniureted hydrogen.

POSTAL ITEMS—*Dingler's Journal* gives the following:—"The number of letters posted annually is estimated at 4,000 millions. The German post-office delivers 300 millions in a year. Wax tablets are first mentioned in the sixth book of the Iliad. The Egyptian papyrus was, for a long time, very dear. In the time of Pericles a medium sized sheet cost 7s. 6d. Parchment was introduced in the third century B. C.; paper was made from rags in Italy, A. D. 1314. The first German paper mill was erected at Mainz. Letters assumed their present form in the fourteenth century. Envelopes were invented in 1820. In 1866, Dr. Stephan invented the postal card, of which 400 millions are now annually used in Europe. Cyrus established the first horse mail. Carrier pigeons were first used in the East. Rome used private letter-carriers in the time of the Republic. Letters from Africa required fifteen to twenty days; from Asia, forty days. Augustus established the first public mail. The mail messengers were called *equites positi*, hence the name 'post.' The German-Austrian postal union began in 1850. The world's postal union now embraces 20 million square miles of territory."

ON THE MINUTE MEASUREMENTS OF MODERN SCIENCE.

By ALFRED M. MAYER.

ARTICLE XVII.

On the Application of Rotating Mirrors to the Measurements of Minute Lengths, Angles, and Times.

ON WHEATSTONE'S EXPERIMENTS TO MEASURE THE VELOCITY OF ELECTRICITY AND THE DURATION OF THE ELECTRIC DISCHARGE.

IN our first article we stated that this series would end with two remarkable *applications*, in which the various methods and instruments described in this series would be

Fig. 51

combined and brought to bear on problems whose solution, at first sight, appears beyond human power. The two problems which we have selected from the extensive array found in the annals of science are: The Measurement of the Velocity of Electricity and the Duration of the Electric Discharge, and the Measurements of the Wave-Lengths of Light. In giving accounts of these problems I will show how men of science have discovered, minutely examined, and measured actions of physical forces which take place in a space less than the 1-10,000th of an inch and endure but a few billionths of a second. Such actions are the flash of the electric discharge and the undulation of a wave of ether in a beam of light.

In 1834 Charles Wheatstone, of London, read a paper before the Royal Society which marks an era in the history of experimental physics. He then first described the application of the rotating mirror to the examination of the nature and duration of phenomena which last but a few thousandths or millionths of a second. This paper of Wheatstone had more effect on the progress of science, from the publication of the method of observing and measuring with the rotating mirror, than by reason of the new facts in the nature of electricity which it gave to the world, though the latter were at that time of the first importance.

The first new application of the revolving mirror was proposed by Arago in 1838. With it he proposed to measure the relative velocities of light in air and in water, and thus to decide whether light in its nature is the rapid translation through space of very minute particles of matter, or whether it is of the nature of undulations or pulses, rapidly transmitted through a rare and highly elastic medium, which must be supposed to exist throughout the universe. If light be of the nature first described it must move more rapidly through water than through air; if of the nature of undulations of an elastic medium, it must move less rapidly in water than in air.

We cannot do better than here let Arago speak for himself on this subject. The following is what he said before the Academy of Sciences of Paris, at the meeting in which he proposed this experiment:

"I propose to show how it is possible to decide, unequivocally, whether light be composed of little particles *emanating* from radiant bodies, as Newton supposes, and as the greater part of modern geometers admit, or whether it is simply the result of the undulations of a very rare and very elastic medium, which physicists have agreed to call *ether*. The system of experiments which I am about to describe will no longer permit, it seems to me, to hesitate between these two rival theories. It will decide, *mathematically* (I use designedly this expression)—it will decide, mathematically, one of the grandest and most debated questions of natural philosophy.

"Besides, my communication is the fulfilling a sort of engagement to the Academy I accepted at one of its last secret sittings.

"I discussed the admirable method, by the aid of which Mr. Wheatstone attempted the solution of the problem of the velocity of electricity over metallic conductors. I had hardly enumerated the important results obtained by that ingenious physicist, when several of our members, whose

Fig. 52

names are authority in such matters, stated that my report was far too approbative. 'In supposing it well determined, the inferior limit assigned by Mr. Wheatstone to the velocity of electricity will not have,' said one. 'any marked influences on the progress of the sciences; besides, limits of the same order, and even more extensive, can be deduced indirectly from various electric and magnetic phenomena. As to the method of the revolving mirrors, it does not seem to be susceptible of application, but to the simple questions already studied by the inventor.' I tried to refute this last opinion. I believed myself that the new instrument, suitably modified, would lead to results that Mr. Wheatstone was not aware of. I already foresaw that, even in supposing it inclosed in the narrow limits of a small room, it could serve to measure the comparative velocities of light moving through air and through a liquid. I was not slow in learning, and without having hardly the right to be astonished or to complain, that my assertion had been received with incredulity. Nevertheless, I intend to vindicate it to-day in all its parts."

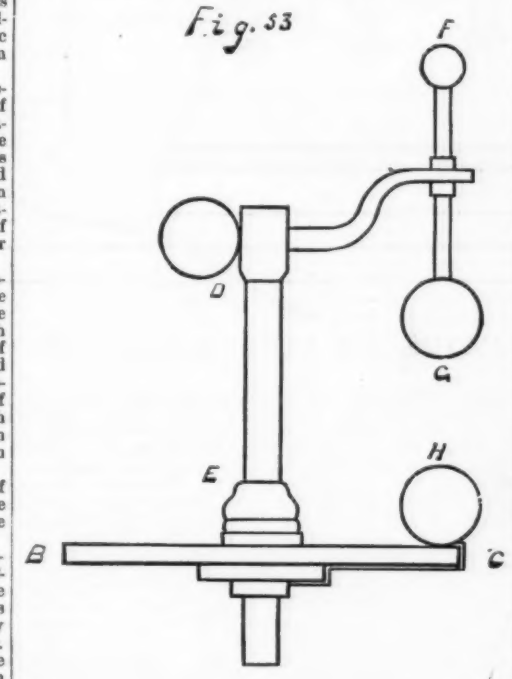
Arago then enters into the most minute details of all the parts of the experiment. The velocity of rotation that can be given to the mirror, the visibility of the image formed by light after having traversed the necessary length of liquid, the possibility of reducing that length of liquid, or the velocity of rotation of the mirror by employing simultaneously several rotating mirrors from which the light would be successively reflected, and also in substituting for water bisulphide of carbon, which acts more powerfully on the velocity of light, are, on his part, the objects of a thorough examination. After the publication of this remarkable communication no one could doubt the success of the experiment which it so carefully and so minutely described.

Failing sight and the infirmities of age prevented Arago from ever putting his proposed experiment to actual test, but, presenting his method to his younger scientific brethren to work out, it was reserved for the talented and lamented Foucault to have the honor of solving the experimental problem with an apparatus similar in principle to that proposed by Arago, but simpler in construction and more precise in its measures. With apparatus Foucault first proved that light moves *slower* in water than in air, and thereby gave to the undulatory theory of light one of its main supports.

The following is the letter, in which Foucault gave the first news of the success of this noble and ever-memorable experiment:

"To the Editor of the *Journal des Débats*—Sir: I will not wait for the expiration of the fortnight to give you an account of what most occupied the Academy of Sciences during their meeting of yesterday. All knew that M. Arago was to continue the account of his beautiful researches in polarization and photometry. The attendance was large, and the Academy recorded at its session a foreign associate and two corresponding members—Sir David Brewster, Lord Brougham, and M. De la Rive, of Geneva. But

Fig. 53



WHEATSTONE'S WHIRLING APPARATUS.

what was not expected was, that M. Arago recalled attention to one of the most beautiful projected experiments that the genius of a savant has ever produced, and he declared that, after having conceived it, he had left to the young generation the care and the honor of performing it. The experiment has more than once occupied the attention of the Academy; it proposes to decide, by means of a revolving mirror, whether light moves faster in air than in water, and to seek, in the probable result of this experiment, the confirmation of the theory at present adopted to explain all optical phenomena. You may judge, Sir, of the emotion with which I heard this generous declaration—I, who for several days had in my hands the experimental solution of this great problem! Nevertheless I thought it proper to postpone to the next meeting the reading of the paper in which I have recorded my results. In the meantime permit me, sir, to announce, in a few words, the results which I have observed.

"Light employs more time to run over the same path in water than in air, and the time which it takes to traverse these two different media is shown by the deviation of a ray which is reflected at a given moment from a mirror revolving with a great velocity. All things remaining equal, the deviations were found to be proportional to the indices of refraction of air and water. It is not possible to entertain the least doubt as to the reality of these results; they have been obtained by two different methods. The two deviations were first observed successively, and were found unequal for the same velocity of the mirror. They were then observed simultaneously, which rendered the observation still more certain. LÉON FOUCAULT."

In 1862 Foucault added various improvements to his apparatus, and brought its measurements to such precision that he measured the velocity of light with accuracy.

"This is an admirable experiment in physics, in which, by the power of intellect and manual skill, he succeeded in not only rendering sensible, but even measurable, the time employed by light to run over a path of 20 meters, although this time barely equals the 1-15,000,000th of a second. . . . .

"We would be unjust if we did not mention that the success of the experiment of Foucault was greatly indebted to Froment, the able constructor of the various parts of the apparatus. The clockwork which gave to the toothed disk a uniform motion of one revolution per second, and the revolving mirror put in motion by the little air-turbine or siren, ought to take rank among the numerous mechanical wonders which have proceeded from his hands. The most ingenious conceptions remain unrealized if they do not find an artist capable of executing them. Thus history has taken care to treasure the memory of eminent mechanicians, to whom are due the delicate constructions which have given important progress to science. The name of the illus-

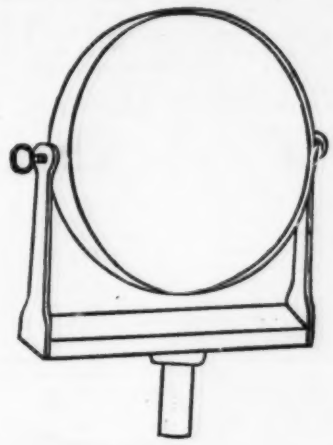


Fig. 54.

trious English clockmaker, Graham, remains forever associated with the discovery of aberration and nutation, made by Bradley with an instrument constructed by that artist; in the same manner the name of Froment will remain inseparable from the beautiful and refined experiment of which we have just spoken, and for which he constructed the important and ingenious improvements added by Foucault to the original apparatus devised by Arago."*

In like manner the name of Joseph Saxton should ever remain associated with Wheatstone's celebrated experiments with the revolving mirror, for to the skill of this eminent American mechanician Wheatstone was indebted for the construction of his apparatus and for valuable assistance given him during his experiments with it. Also, it is not improbable that the fact of Saxton's having previously used the revolving mirror in the examination of phenomena of momentary duration may have suggested to Wheatstone the application of the revolving mirror to the investigation on the velocity of electricity and the duration of the electric discharge. This investigation we will now proceed to describe.

It will render easier the understanding of Wheatstone's experiments by prefacing our description of his work with a fact or two in physiological optics which lie at the foundation of his method of experimenting.

Imagine a minute bright spark, or *dot* of light, which appears but for an instant—say that it lasts only the 1-100,000th of second. The eye, of course, can receive light from this spark only during that minute interval of time, yet the *sensation* produced by the light from the spark lasts much longer; so that after the spark has really ceased to exist the eye perceives the spark as existing. The duration of this *apparent existence* of the spark depends on the intensity of its light, and may last from 1-10th of a second to over a whole second of time. It is therefore evident that the unassisted eye can never determine the actual duration of flashes of light which have minute periods of existence; for in a series of sparks, all of the same intensity of light, and whose durations extend from 1-100,000th of a second to one-half of a second, the eye will see each spark, lasting the half of a second, if this is the duration of the sensation of light of the intensity of the sparks.

The eye, therefore, has to call in instrumental aid. This is afforded by some contrivance which will move either the spark *or its image*, and if the spark has a duration at all comparable to the time during which it has been moved, it will be drawn out into a line which has its length in the direction in which the spark or its image has been moved. Thus, for example, suppose that the spark is a mere *dot* of light—not a line—and has lasted 1-100th of a second, and that during this 1-100th of a second the spark was moved from

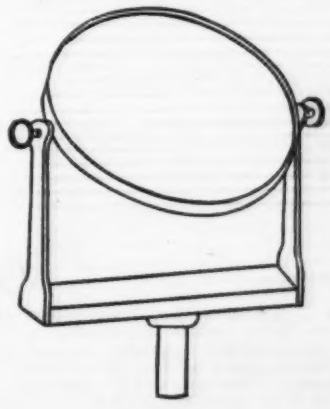


Fig. 55

right to left through one inch. Then, on account of the persistence of the sensation of light on the eye, the spark will appear as a horizontal line of one inch in length. If the velocity of the motion of translation remains the same and the spark lasts only a fraction of 1-100th of a

* See "Essay on the Velocity of Light," by Delaunay. Translated by the writer and published in Smithsonian Report, 1864.

second, then it will appear drawn out into a line whose length is the same fraction of an inch.

Now, imagine that the spark is not a dot of light, appearing stationary at one point in space, but is a dot which *moves* between two points in the manner in which we may suppose an electric spark to move from one brass ball to another. Look at Figs. 51 and 52, and imagine that an electric spark flashes between the balls placed at A and B, then this spark will appear to you as a line of light drawn between A and B. Now suppose that the spark really goes downward from A to B, as in Fig. 51, and in the time it takes to go from A to B, the balls, A and B, have moved from right to left over the distance equal to B from C, then the line of light will not longer appear as a vertical line, A B, but will be seen as the inclined line, A C. If the spark moves upward from B to A, as in Fig. 52, while the balls, as before, go from right to left over the distance, B C, then the spark will appear as the inclined line, B D, of Fig. 52.

Wheatstone having failed to produce any change in the vertical direction of the spark during its lateral motion, varied his mode of experimenting, and, instead of moving the spark apparatus, he allowed it to remain stationary, and moved laterally with great rapidity the image of the spark by viewing its reflection from a revolving mirror, whose axis of rotation was parallel to the line traced by the spark. The advantages of this method of experimenting are various. A small angular deflection in the plane of the mirror produces a large deflection in the reflected image of the spark, for the angular motion of the image is double that of the mirror. (See the description of Fig. 33 in Article XI.) Also, the same mirror may be used in different researches, and, indeed, forms an instrument universally applicable to the examination of the nature of various transient phenomena.

Two forms of rotating mirrors are proposed by Wheatstone. One of these is represented in Fig. 54. It rotates about a vertical axis, and this motion successively brings its reflecting surface into every vertical plane. As the angular motion of the reflected image is double that of the mirror, it follows that a reflected image, such as that of a candle flame, will go over an entire circumference while the mirror makes one-half of a revolution; and if the mirror be silvered on its back as well as on its front, then one entire revolution of the mirror on its axis will cause the reflected image of the flame to go over two entire circles. If the mirror rotates with sufficient rapidity the observer will see the reflected image of a luminous point drawn out into a horizontal line, which line is a part of the entire circumference traced by the reflected point; in other words, is an arc of the circle described. This arc is larger in extent in proportion as the eye is nearer the mirror.

If, while this mirror is rotating, a luminous point, viewed in it, should move in a vertical direction, that is, parallel to the axis of the mirror, it is evident that this motion would be combined with the lateral motion of the point, produced by reflection, and a resultant motion would be produced, as has already been described in connection with Figs. 51 and 52. Knowing the number of rotations made by the mirror in a second and the direction of its rotation, we can compute the velocity and direction of the moving luminous point.

Wheatstone fastened the axis of this mirror to a machine with multiplying wheels, and made the mirror revolve fifty times in a second. This velocity of rotation caused the reflected image of a luminous point to go over one-half of a degree of arc, or 1-720th part of the circumference, in the 1-72,000th of a second. This luminous arc of one-half of a degree is easily perceived by the unaided eye, and is about equal to an inch in length, seen at a distance of ten feet.

Of the results of this new experiment, Wheatstone says:

"I successively presented to the mirror sparks four inches in length, drawn from the prime conductor of a powerful electrical machine; the explosions of a charged jar; a glass tube four feet in length, exhibiting a spiral of electric sparks passing between dots of tin foil; an exhausted glass tube six feet in length, through which the spark passed, and produced an unbroken line of attenuated electric light; various pictures, such as birds, stars, etc., formed of electric sparks. But in all these cases, when the reflected images occurred within the field of view, they appeared perfectly unaltered, and precisely as they would have done had they been reflected from the mirror while at rest.

"When sparks were made to follow each other quickly several reflected images were simultaneously seen in different positions, owing to the images having been renewed before the visual impression caused by the first had disappeared. The exhausted tube being held near a prime conductor, when looked at directly, will sometimes appear to gleam with a continuous light, but, examined in the mirror, this apparent continuity is seen to be owing to a rapid succession of transient flashes."

At this point of our study of these phenomena, and of the means of investigating their nature, we have very carefully to distinguish between two things to be observed and interpreted in the appearance of the moving spark when viewed in the rotating mirror, which we have just described; viz., first, the breadth of the line traced by the spark, and, secondly, the amount of deflection, or inclination, of this line. The first of these appearances is produced when *the duration* of the spark is appreciable when timed by the motion of the mirror, and the second is seen when *the velocity* of the spark is so low that the mirror has had time to move the spark's image laterally while the spark is going from one electrode to the other.

It is evident that, if the spark is really seen as a line of

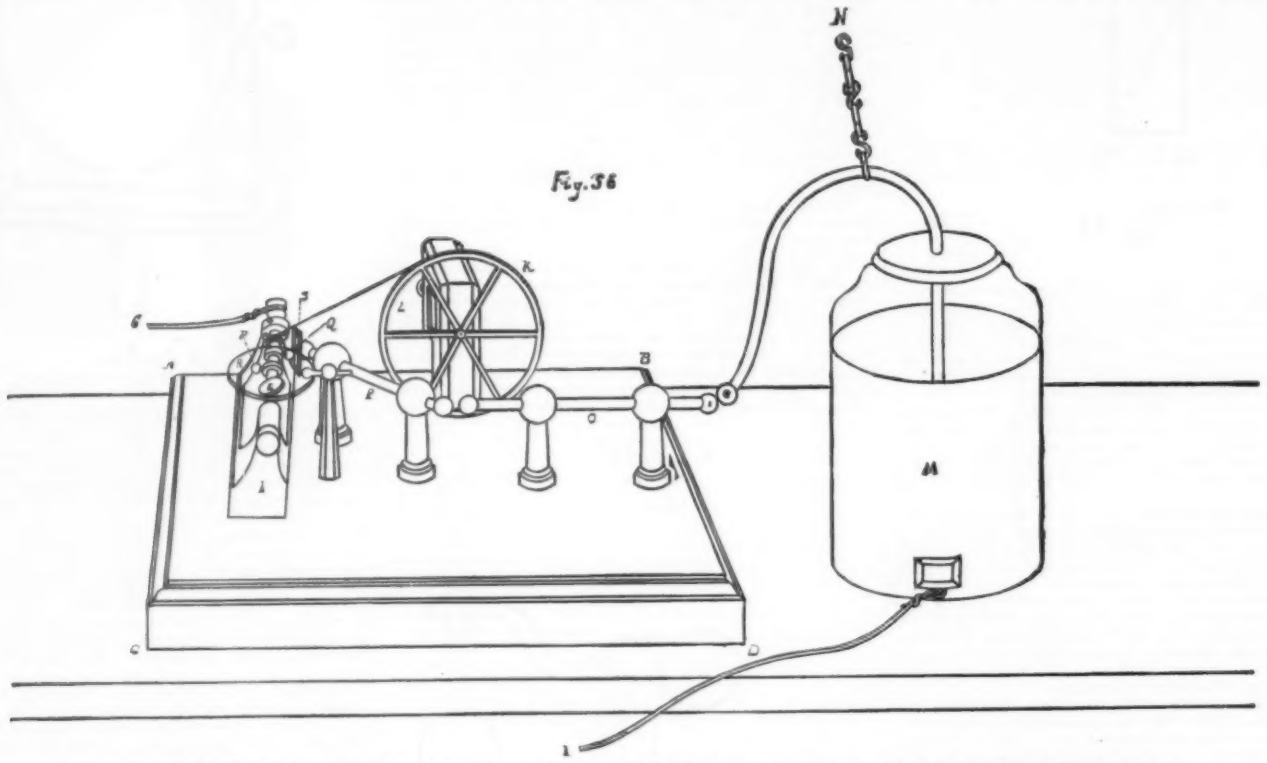


Fig. 56

WHEATSTONE'S APPARATUS FOR DETERMINING THE VELOCITY OF LIGHT.

In Wheatstone's first trials he actually made an apparatus do what we have just described, the balls moving rapidly across the line of sight while the spark was passing between them. The following is his description of the apparatus and the experiments:

"Fig. 53 represents the apparatus employed, which was screwed at A to the spindle of a whirling machine, so that a rapid rotatory motion might be given to it. The upper and lower parts, which were all of brass except the wooden disk, B C, were insulated from each other by a stout glass rod, D E; a strip of tin foil connected the ball, H, with A, and the upper ball, G, was capable of adjustment to various distances from the lower one, H. When the ball, F, was placed within striking distance of the prime conductor of an electrical machine, a spark passed between them, and also between the balls, G and H, which could be separated to the distance of four inches, so as to exhibit a spark of that length. It is obvious that, if the angular motion of the balls were in any sensible proportion to the velocity of electricity, there would be a deviation between the upper and lower terminations of the line. The instrument moving from left to right, if the motion of the spark be downward, the deflection of the line should be as in Fig. 51, and if its motion be upward, it should be deflected, as in Fig. 52.

"When the apparatus was made to revolve rapidly the sparks passed in the same manner as when it was at rest, and no deviation of the extremities of either of the two sparks from the same vertical line was observed. The apparatus revolved fifty times in a second, and as a difference of the twentieth part of the circumference described by the balls could easily have been observed had it existed, we may safely conclude that the spark passed jointly through the air and the metallic conductor in less time than the 1-1,000th of a second."

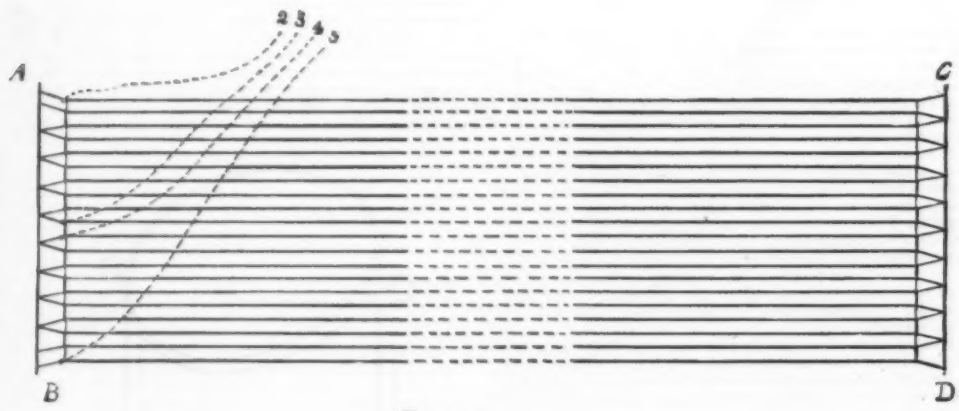


Fig. 57.

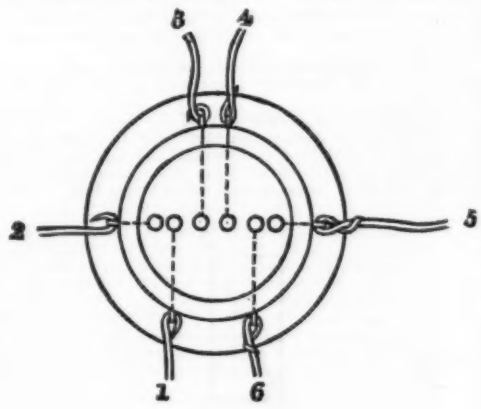


Fig. 58

light joining the two balls (or other electrodes), it must have an *entire* duration equal to the time it has taken to go over the space separating the electrodes. Yet the spark, *at each point of its path* between the electrodes, may have so small a duration that the mirror may not be able to *appreciably* widen its trace; especially when the lateral deflection or inclination of the whole vertical trace of the spark is just sufficient to be detected and measured in the rotating mirror. So we have to look for and to measure two dimensions in the image of the spark. *Its change in width* compared to what it has when at rest gives the duration of the spark's existence *at each point in its path*, while the measure of *the lateral deflection* of the track of the spark gives us the means of computing its velocity. These are points to be well understood in order to interpret the appearances given by experiment on the electric discharge.

The second arrangement of rotating mirror proposed by

Wheatstone is shown in Fig. 55. The reflecting surface of this mirror is inclined to the axis of rotation and nearly perpendicular to it. If a luminous point be placed anywhere in the prolongation of the axis of rotation it will be reflected, so that by the rotation of the mirror and the persistence of visual impressions, it will appear in a smoky room as a luminous cone, and the base of this cone will appear on the ceiling as a luminous ring, forming a circumference of a circle, whose center is on the axis of the mirror prolonged. In this form of experiment the angular velocity of the image is equal to that of the mirror, and both move in the same direction.

Wheatstone thus describes his experiments with this mirror: "The flame of a candle presented to it appears as a broad luminous ring; the image of the sun is converted into a magnificent fiery belt, etc. A series of minute sparks made to pass between two points, or between a point and the prime conductor of a machine, presents to the eye, from the rapidity of their succession, the appearance of a permanent star of light. When this star is placed in the prolongation of the axis of the revolving mirror, the successive sparks of which it consists are reflected to the eye, each from a different part of the surface, and they are exhibited arranged at regular distances in a circle. When the intermissions are rapid, the appearance is extremely beautiful.

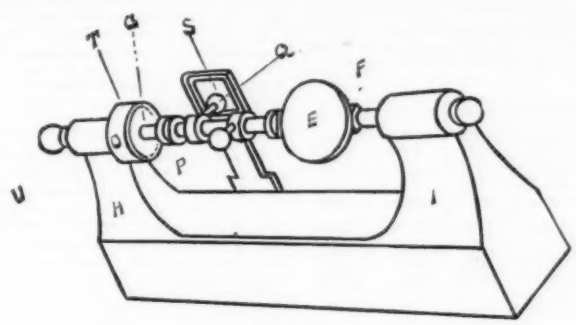


FIG. 59.

"The brush of light which appears on a point when presented at some distance from the conductor, is also by this means shown to be an intermittent action, notwithstanding its permanent appearance; its reflected images present, however, this remarkable peculiarity, they are elongated in the direction of the motion, proving that the brush is not so transient as a spark, and that the emissions which constitute it last during one interval of time measurable by the motion of the mirror.

"But this instrument is not confined to observe merely the intermittences of electric light; whenever a rapid succession of alterations occurs in an object which does not change its place, they may be separately examined by this means. Vibrating bodies afford many instances for investigation; one among them is perhaps worthy to be mentioned. A flame of hydrogen gas burning in the open air presents a continuous circle in the mirror; but while producing a sound within a glass tube, regular intermissions of intensity are observed, which present a chain-like appearance, and indicate alternate contractions and dilatations of the flame corresponding with the sonorous vibrations of the column of air."

To increase the chances of observation of sparks, etc., when their appearance cannot be commanded at the instant when the mirror is in the position to reflect them to the eye, Wheatstone proposes the use of a mirror formed of a hexagonal prism with polished faces, as shown in Fig. 60, where A B is the axis of rotation, and C, D, E, three of the reflecting facets. With this mirror the observer will have six chances of seeing the reflected image instead of only one, as he has when using a rotating mirror with one polished surface.

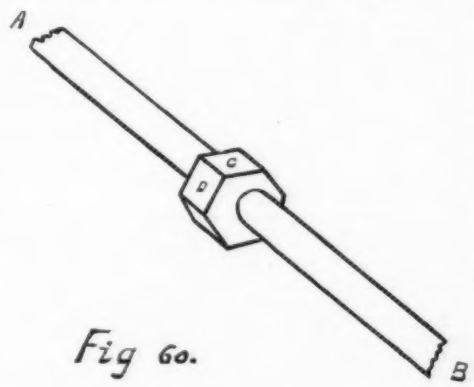


Fig 60.

On the Determination of the Velocity of Electricity through Conducting Bodies.—In the trials made to find out the velocity of electricity previous to Wheatstone's experiment, they used a long conductor, whose two ends were brought near each other so as to form a nearly closed circuit. One of these ends was placed at a short distance from a wire which went to earth, the other end was placed near a conductor leading to an electrical machine, or battery of jars. The experimenters had hoped to have seen an appreciable interval between the passage of the spark to one end of the conductor, and its appearance at the other end on its way across the space to the wire which led to the earth. In one experiment made near London in 1747, they used four miles of conductor, and the discharges at the two ends of the circuit appeared to be simultaneous to the experimenters; and naturally so, for if they had been separated by the 1-10th of a second the discharges would have appeared simultaneous by reason of the persistence of the sensation of light; and though they might have detected by the ear an interval of 1-10th of a second separating the sounds of the discharges, yet they would not have been able to detect an interval of silence between discharges separated by 1-100th of a second. It follows that in a circuit of four miles the detection of a velocity of only a few miles a second would be the limit to such methods of observation, even allowing that the method under any circumstances would give a result indicating an actual transfer of electricity from one end of the conductor to the other.

Wheatstone, after speaking of these trials, says, "I determined, therefore, to repeat a similar experiment, substituting for the imperfect judgment of the eye a revolving mirror, but more rapid in its motion and accurate in its indications than any I had previously employed. The instrument I am about to describe will, unless there be some error in the estimate, which I have not been able to perceive, measure beyond the millionths of a second; and this degree of minuteness may be yet far surpassed by more costly instruments and more careful observations."

It is often stated in text-books that Wheatstone's experiment on the velocity of electricity favors the hypothesis of two electric fluids. That this opinion should be so generally diffused is not a little remarkable, and when the reader has perused the following paragraph he will see that Wheatstone says distinctly that the expected result of his experiment is as readily explained by the hypothesis of one fluid as by that of two fluids. "But," speaking of the experiment of 1747, "as it is only on the hypothesis of an actual transfer of a fluid from one end of the wire to the other that a difference of time between the two sparks at its opposite extremities might be expected to be observed, in order to render the proposed experiment independent of this theoretical view, I took the necessary precaution of bringing a third spark, formed by disconnecting the middle of the wire near to and in a line with the extreme sparks. For on the supposition of the transfer of two fluids in opposite directions, the extreme sparks would be simultaneous, but the middle spark later in its occurrence; the same appearances would also accord with the theory of one electricity, if we admit that a disturbance of electric equilibrium is simultaneously propagated from each end, arising in the one case from successive additions to, and in the other from successive subtractions from, the neutral quantity in the conducting wire."

The experiment of Wheatstone's was made in the Adelaide Gallery of Practical Science, London, where our countryman, Saxton—who aided Wheatstone in these experiments—was then exhibiting his magneto-electric machine and other ingenious inventions. The total length of wire used was half a mile. This was stretched between the balustrades (A B and C D of Fig. 57) of the gallery in 20 parallel lengths, each 120 feet long. The ends of the wire marked 2, 3, 4, 5, of Fig. 57, were connected to the similarly numbered wires of the *spark board*, shown in Fig. 58. This spark board was fixed against the wall, so that the six balls (shown as circles in the figure) should be in a horizontal direction and parallel to the axis of the rotating mirror. The distance shot over by the sparks was 1-10th of an inch. The conducting wire was of copper and 1-15th inch in diameter.

Fig. 56 gives a general view of the apparatus to rotate the mirror and its electrical connections with the Leyden jar, M, and the conducting wire and spark board through the wires marked 1 and 2. Fig. 59 is an enlarged view of the mirror and the attachments thereto which Wheatstone used to obtain the spark at the right instant for observation, and to determine the number of revolutions made in a second by the axis of the rotating mirror. Similar parts in the two figures bear the same letters. The mirror, E, is of polished steel, one inch in diameter, and mounted on the shaft, F G, so that the plane of reflection of the mirror is in line with the axis of rotation of the shaft. The mirror was rotated by a cord going over the wheel, K L, and a groove in the axis, F G. This wheel, K L, was so large that, if the cord is supposed not to slip, the axis, F G, will make 1,800 revolutions to one of the wheel. M is a small Leyden jar, which is kept constantly charged with positive or negative electricity by means of the chain, N, connected with an electrical machine. From the inner coating of the jar leads a bent wire to the two insulated rods, O and P. The ball on the end of P is quite close to the knob, Q, on the axle, F G, when this knob comes opposite the ball on O in the rotation of this axle. In order to confine to narrow limits the spark which passes over this interval, Wheatstone placed between the knob, Q, and the ball on O a piece of mica, S, with a narrow horizontal slit in it. When the plane of the mirror is stationary and at 45° with the horizon he saw, on looking down vertically into it, the image of the balls on the spark board. Charging the jar, M, and rotating the mirror, the observer saw three sparks pass on the spark board and another pass from the knob, Q; through the slit in the mica to the ball on O. The path of the electricity may be supposed, for simplicity of explanation, to go from the outside surface of jar by the wire 1 to the wire 1 on the spark board; thence, with a spark to wire 2, and through half of the stretched parallel wires to 3; thence with a spark to wire 4; thence through the remaining half of the stretched wire to 5; thence with a spark to 6, and back to wire 6, attached to the standard of rotating apparatus and to the inner coating of the jar.

Without a knowledge of the exact number of revolutions made by the mirror in a second one cannot compute the value of deflections of the sparks in case they should be appreciable, and Wheatstone spent much time in the endeavor to get the exact velocity of the mirror. At first he used a siren, shown in Fig. 59, at T, attached to the axle, F G. With 800 revolutions to the axle, and leading air to the siren even through a few holes, the sound produced was so acute that it was either inaudible or its pitch was so high that the ears could not determine the note, and when the number of holes were reduced so as to lower the pitch the sound was too feeble to be distinctly heard. He then simply placed a small piece of paper so that the arm, P (which acts as a counterpoise to the arm and knob, Q), would strike it once at each revolution of the shaft of the mirror. When the mirror was now revolved with the maximum velocity the knob striking against the paper caused the sound G—⁴, which showed that the mirror was making 800 revolutions in one second of time. In subsequent experiments Wheatstone used a counter attached to the shaft of the mirror, and when thus retarded by this additional work put on it, the shaft made 600 revolutions per second.

Of the extraordinary powers of this apparatus as an instrument of research, and of the results of his experiments with it, Wheatstone speaks as follows: "Let us now consider what is the shortest duration of the electric light, and the greatest velocity of transmission through the wire, that can be detected by means of the instrument I have described. The mirror revolves 800 times in a second; and during this time the image of a stationary point would describe 1,600 circles: the elongation of a spark through half a degree, a quantity obviously visible, and equal to one inch seen at the distance of ten feet, would therefore indicate that it exists the 1-1,152,000th part of a second. The deviation of half a degree between the two extreme sparks, the wire being, as above stated, half a mile in length, would indicate a velocity of 576,000 miles in a second. This estimated velocity is on the supposition that the electricity passes from one end of the wire to the other; if, however, the two fluids in one theory, or the disturbances of equilibrium in the other, travel simultaneously from the two ends of the wire, the two external sparks (on the spark board) will keep their relative positions, the middle one will be alone deflected, and the velocity measured will be only one half that in the former case, viz., 288,000 miles in a second.

Repeated experiments gave the following results. In all cases, when the velocity of the mirror exceeded a certain limit, the three sparks were elongated into three parallel lines, and the lengths became greater as the velocity of the motion was increased. The greatest elongation observed was about 24°, indicating a duration of about the 1-24,000th of a second. The lines did not always commence at the same places; sometimes they appeared immediately below the eye, sometimes to the right, at other times to the left, and occasionally they were out of view altogether. This indetermination is owing to the arm, 2, of Fig. 59, not always taking the spark at the same distance from the discharger: several discharges are therefore required to be made before the eye can distinctly observe the appearances. When the velocity was low the terminating points (*i.e.*, the ends of the luminous lines of the elongated spark images) appeared in the same horizontal line; but when the velocity was considerable, and the upper edge of the mirror was revolving from the observer, the lines assumed this appearance ||| ; when the top border of the mirror revolved toward the observer the lines appeared thus ||| . In no case did I see them thus ||| , or thus ||| , as required in the actual transfer of a single fluid. The spark board in all these experiments was placed at the distance of ten feet from the mirror.

The interpretation of these appearances observed by Wheatstone in his mirror is as follows: First, the mirror in its revolution had time to turn 12°, while the spark lasted between the balls on the spark board, and as the mirror produces in the image double the angular deflection of its own motion, the spark appeared elongated over an arc of a circle equal to 24°. Since the mirror, by one revolution, spreads a reflected image out into two complete circles, or $2\times360°=720°$, it follows that 800 turns per second of the mirror spreads out a reflected image into $800\times720°$, or $576{,}000°$; and $\frac{576{,}000}{24}=24{,}000$. Which gives 1-24,000th second for the duration of the spark on the spark board in Wheatstone's experiment.

The observer sees another peculiarity of these elongated sparks; they are parallel, but they do not have their origin on the same horizontal line. When the mirror in its motion is deflecting the spark image downwards, they present this appearance ||| , which shows that the sparks at the beginning and the end of the wire, or circuit, took place at the same instant, and that a small interval elapsed before the spark made its appearance at the broken place in the middle of the wire, and that during this small interval which elapsed the mirror had time to get a slightly greater tilt then that which it had when the side sparks appeared, so the middle spark line appears as pushed *downward* between the two side spark lines. When the mirror revolves so that the images of the sparks are drawn out in an upward direction, then the middle spark line appears slid *upward*, between the two side lines, by the same quantity that it was slid downward by the same velocity and opposite direction of rotation of the mirror.

Wheatstone states that the amount of downward or upward displacement of the middle spark line amounted to not more than one half of a degree. Now, as an elongation of 24° in the spark line gave 1-24,000th of a second for their duration on the spark board, it follows that the displacement of half of a degree gives us 1-48 of 1-24,000th of a second, or 1-1,152,000th of a second. for the time it took the electricity to go over ¼th of a mile, or half of the entire length of the copper wire; hence in one second, electricity, according to Wheatstone's experiment, will travel over $\frac{1{,}152{,}000}{4}$, or 288,000 miles of copper wire.

The very large elongation of 24° in the sparks produced in the peculiar and unusual conditions of these experiments led Wheatstone to hope to be able to elongate sparks as they are ordinarily produced by the discharges of electrical machines or Leyden jars through short conductors of very slight resistance; but he observed no elongation in the sparks even when the mirror was urged to the greatest velocity of rotation. This shows that electric discharges taking place under the above conditions cannot have an existence as long as the 1-1,152,000th of a second; for if they had had a duration of that length then Wheatstone would have caused an appreciable elongation in them. Frequently we meet with the statement that Wheatstone showed that the discharge of a Leyden jar lasts the 1-24,000th of a second. We see that Wheatstone distinctly

states that this is the duration of the discharge in the conditions of his experiment, and that in the usual conditions of discharge its duration is not equal to the 1-1,000,000th of a second. Indeed usually the spark has an existence which is only stated in billionths of a second, as we shall see in our next article, where we will give an account of the remarkable researches of Rood, Feddersen, and others.

Wheatstone thus explains the extraordinary durations of the sparks from his apparatus: "The elongation of the sparks at the interruptions of the wire above noticed were no doubt owing to this circumstance, that the diameter of the wire was not sufficiently great to allow the charge of the jar to pass through it except in a successive manner. The duration of the discharge in the cases of these sparks appeared to be longer than the time required for the electricity to pass through many miles of wire.

"The sparks from the great magnet constructed by Mr. Saxton, which is at the Gallery in Adelaide Street, were considerably elongated, even when the mirror was moving with a comparatively low velocity."

Wheatstone closes his remarkable paper with these words: The instantaneousness of the light of electricity of high tension, rendered evident by the preceding investigations, affords the means of observing rapidly changing phenomena during a single instant of their continued action, and of making a variety of experiments relating to the motions of bodies when their successive positions follow each other too quickly to be seen under ordinary circumstances.

A few obvious instances will at present suffice. A rapidly revolving wheel, or a revolving disk on which any object is painted, seems perfectly stationary when illuminated by the explosion of a charged jar. Insects on the wing appear, by the same means, fixed in the air. Vibrating strings are seen at rest in their deflected positions. A rapid succession of drops of water, appearing to the eye a continuous stream, is seen to be what it really is, not what it ordinarily appears to be, etc.

The preceding experiments having been directed rather to detect elongations and deviations than to measure them, I am not prepared to state the results with numerical accuracy. I shall endeavor to supply this deficiency in further investigations, but must at present content myself with stating the following general conclusions, deduced from the appearance which I have observed, though, I must allow, more accurately performed experiments are required before they can be considered as fully established.

1st. The velocity of electricity through a copper wire exceeds that of light through the planetary space.

2d. The disturbance of electric equilibrium in a wire communicating at its extremities with the two coatings of a charged jar, travels with equal velocity from the two ends of the wire, and occurs latest in the middle of the circuit.

3d. The light of electricity in a state of high tension has a less duration than the millionth part of a second.

4th. The eye is capable of perceiving objects distinctly, which are presented to it during the same small interval of time.

By prosecuting these researches with instruments of higher power, and of greater accuracy in their indications, numerical laws may be established for a large class of phenomena, the relations of which we have had hitherto no means of observing. The relative velocities of electricity in different metallic wires; the modifications in the velocity of electricity in different states of tension when passing through the same conductor, if any such differences exist; the duration of the electric spark under different circumstances of tension and quantity, etc., will be among these objects of investigation.

THE PHONEIDOSCOPE.

THE object of the phoneidoscope is to show, optically, the delicate particularities of sonorous vibratory movement. A thin film of liquid glycerine is formed on a small opening made in a piece of blackened brass, and it reflects the light of a lamp in producing, either on the retina direct or by projection on a screen, the well known iridescent effects of thin transparent plates. As long as the film is motionless, the simple colors of iridescence are alone visible. But if, by means of a bent tube, the vibrations of a sustained sound are conducted underneath that film, by the voice or otherwise, the film begins to vibrate and the colors are distributed geometrically, producing on the surface fixed bands and moving rings, the disposition of which varies with the depth of the tone and the nature of the harmony accompanying it—that is to say, the pitch. At a recent meeting of the French Physical Society, the inventor, M. Taylor, showed by projection that the acoustic figures thus obtained become more and more complicated as the tone emitted rises, or when, the height remaining constant, different vowels are pronounced. The colors thrown on the screen diffused during the experiment in proportion as the film became thinner by evaporation, but the acoustic figures did not vary. The results obtained are extremely curious and of varied appearance, according as apertures of different form are used. M. Taylor projected the phenomena produced by openings, triangular, square, and round, by means of the Drummond light. The considerable heat which accompanies that process of lighting causes, after a certain time, the evaporation of the film of glycerine, and terminates the experiment. But its duration may be augmented by passing the luminous rays through a glass flask filled with water, which deprives them of the greater portion of the qualities absorbable by the liquid glycerine.

EXPERIMENTS WITH THE SILICATED CARBON AND SPONGY IRON FILTERS.

MR. G. W. WIGNER, F.C.S., has recently made a series of experiments with the spongy iron and silicated carbon filters, and the following appeared from his pen in the *Analyst*:—The Margate water, besides being evidently contaminated by infiltration from the sea, has a very unpleasant smell and taste, and the microscope shows a variety of objects which might be more readily passed in surface drainage than in drinking water. It was therefore fairly suitable for such an experiment. The two filters chosen were perfectly new and bought direct from the makers. I did not consider it of any use to test these filters while quite new, as it must be evident that if they were not capable of working satisfactory for a few weeks on such water as that used the experiment was concluded. They were therefore put up side by side—filled regularly as nearly as possible with the same quantity of water, and at the same time, the amount being two gallons per day each and allowed to work thus for five weeks. During this time I found that the silicated water was always preferred for table use. Even those who were entirely ignorant of the fact that filters were used, would sometimes complain of a flat taste in the spongy iron water. Each filter possesses advantages peculiar to itself, so I determined, in addition to testing the water which had simply passed through each filter, to test samples which had passed through both, and as it seemed possible that the order in which the filters were used might make some difference, it was decided to try with silicated filter first and with spongy iron first. I therefore had in all five samples, viz.:—(1) Water from main; (2) water filtered through silicated carbon filter; (3) water filtered through spongy iron filter; (4) water filtered first through silicated carbon and secondly through spongy iron; (5) water filtered first through spongy iron, and secondly through silicated carbon. The samples were distilled for ammonia as soon as possible. The following are the results of five analyses:—

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
	Tap in main.	Silicated carbon filter.	Spongy iron filter.	First, silicated. Second, spongy.	First, spongy. Second, silicated.
Colour	Yellow green, slightly opaque.	Pale blue.	Pale blue.	Opaque blue.	Chalky blue.
Suspended matter	Traces.	None.	None.	Traces.	Slight traces.
Smell	Offensive.	Very slight.	Offensive.	Decidedly offensive.	Decidedly offensive.
Taste	Slightly offensive.	Saline.	Saline and offensively flat.	Unpleasant and very flat.	Excessively flat and objectionable.
Hardness before boiling	27·2 deg.	16·9 deg.	11·6 deg.	14·0 deg.	17·1 deg.
Hardness after boiling	9·4 deg.	5·3 deg.	9·2 deg.	10·7 deg.	7·2 deg.
Total solids	69·60	66·90	58·35	69·75	69·75
Loss on ignition	5·80	6·80	5·35	4·50	9·40
Tot. mineral matter	63·80	60·10	53·00	55·00	60·35
Chlorine as chloride of sodium	36·06	36·06	36·46	36·50	36·50
Nitrogen as ammonia	None.	None.	·0728	·0875	·0149
Do. albuminoid ammonia	·0823	None.	·0161	·0140	·0651
Do. nitrates	·7500	·7300	·6600	·6600	·7300
Do. nitrates	Traces.	Traces.	Traces.	Traces.	Traces.
Total nitrogen in these four forms	·7323	·7300	·7489	·7615	·7500
Oxygen absorbed from permanganate	None.	None.	·0030	·0014	·0183
Microscopical examination of residue	Very bad animal and vegetable debris. Some small spores. Quartz.	Organic debris minute traces only. Mineral matter traces.	Satisfactory. It was very free from suspended matter.	Satisfactory.	Satisfactory.

On looking at these results, the first general feature which deserves attention is that the two filters when used together do not appear to have effected any additional purification, but rather the reverse. It is very difficult to account for this fact. In both cases an ample quantity of the once filtered water was allowed to flow through the second filter so as to rinse it out, and the rinsings were rejected. It is true the filters were not continuously worked under these conditions for any length of time, but this ought hardly to be an essential for this experiment. Leaving this I would next point out the special features shown by columns No. 2 and No. 3, which are the two filtered waters, as compared with column No. 1, which is the unfiltered. Both filters have equally removed the yellow green color of the water and the suspended matter. The silicated filter has greatly reduced the smell, but the spongy iron has merely changed its character, so that instead of resembling decaying vegetable matter it is a sort of indescribable smell, perhaps more resembling the smell of impure hydrogen produced by the action of acid on iron than anything else, but of course very faint, though offensive. The taste has apparently been affected in a similar way. The silicated removed the offensive taste, and left only the saline. The spongy iron left the saline, but added to it a taste a little worse than if the water had been boiled, that is there was something besides the flat taste. Bischof has alluded to a gas which he has observed within the bulk of spongy iron after it had been in use some time, which gas he says is sometimes explosive, sometimes not, and on one occasion he found this gas to contain a hydrocarbon; may not this hydrocarbon be the cause of this smell and taste? The effects of the hardness are singular. The silicated reduced the temporary hardness by 6·2 deg., and the permanent hardness by 4·1 deg., total reduction 10·3 deg. The spongy iron reduced the temporary hardness by 15·5 deg., but only reduced the permanent hardness by a decimal. The spongy iron reduces the total hardness the most, but bearing in mind the greater importance of permanent hardness, there is probably little to choose. It is remarkable that the reduction of total mineral matter does not more closely follow this reduction of hardness. I have not yet made full mineral analyses of the residues to determine this point. It is, however, in the ammonia and albuminoid ammonia, which are so often viewed as almost the sole proof of purity or otherwise, that the most important results appear. The silicated removes even the small proportion of albuminoid ammonia which was present, but the spongy iron produces a very marked proportion of free ammonia and so much albuminoid ammonia that the water would probably be condemned by those who trust mainly to that determination. This result is a serious one, in whichever light we view it. If the albuminoid ammonia determination is of value, then *pro tanto* the filtered water is worse than the unfiltered. If the filter is a good one, and certainly many other experiments have pointed out that it is, then any analyst who reported on such a water, in ignorance of the fact that it had been through spongy iron, might be deceived. But still further, if spongy iron acts in this way, is it possible that metallic iron may in a less degree? In considering this point all the special circumstances of the case must be borne in mind. For instance, the very saline character of the water, and the fact that this salt is partly due, in all probability, to the infiltration from the sea, but still the fact remains. It is unnecessary to go at length through the other columns. It is well, however, to point out that when two filters were used, in the case where the spongy iron was last the ammonia and albuminoid ammonia were almost as high as in No. 3, while, where the silicated was last, they were far less, though not so low as when the water passed through the silicated only. It would be very desirable to have reports of similar trials on the water supply of other places, but I hope it will be possible to take the precaution of using new filters and keeping them at work for a month before taking the samples.

THE ARTIFICIAL SYNTHESES OF ORGANIC COMPOUNDS.

EXTRACT from a paper read before the California Academy of Sciences, by John M. Stillman, of the University of California.

I wish this evening to mention a few of the more striking examples of those discoveries of organic chemistry, where the products of nature have been produced by the hands of the chemist, and to show you the successive steps of the processes, that you may see for yourselves how completely the wall between organic and inorganic has been overthrown; what complex compounds may be obtained by care and patience in the domain of organic chemistry. I shall not allude to the immense number of compounds which organic chemistry has prepared, which have not been discovered in animal or vegetable organism, some of which, as the aniline dyes, have given rise to industries valued at the present day at millions of dollars, but shall confine myself to those products where the laboratory has succeeded in reproducing natural products of vital force in the animal or vegetable organism.

It is true that the artificial method of production is sometimes more expensive than that by which it is produced in nature's laboratory, but this is not always so, and there is always a prospect of new methods and new information giving a cheaper product than nature can produce.

In every case we will follow the process step by step from the elements themselves or from simple inorganic constituents, and every step shall be one which has actually been performed by chemists of repute. To commence with some of the simpler compounds, we will take first

FORMIC ACID.

This compound was first obtained from the bodies of ants by distilling with water; formed, therefore, under the influence of vital force in the animal organism.

In the laboratory it can be obtained readily by convenient methods from other organic compounds, but also by the action of CO and KHO, which gives formic acid in combination with potassium, ($KHO + CO = KHCO_2$) which, when treated with dilute sulphuric acid, gives the free *formic acid*, ($2HK\,CO_2 + H_2SO_4 = H_2CO_2 + K_2SO_4$), identical in all properties, physical and chemical, with the formic acid derived from the ants themselves; is, in fact, the same compound.

ALCOHOL

Is another product of organic life, and occurs in the decomposition of juices of plants containing sugar. It also can be built up from inorganic constituents, as follows:

Carbon and hydrogen unite directly to form acetylene, C_2H_2, under the influence of the electric spark.

This compound, acetylene, by the action of hydriodic acid gives ethane—$C_2H_2 + 4HI = C_2H_6 + 4I$, C_2H_6; and this in turn with chlorine gives $C_2H_6 + Cl_2 = C_2H_5Cl + HCl$, which when treated with AgOH gives alcohol, ($C_2H_5Cl + AgOH = C_2H_5OH + AgCl$) *identical* with the compound produced by fermentation.

By oxidizing alcohol we also obtain another compound, which is also an organic product, viz.: *Acetic acid.*

$$C_2H_6O + O_2 = C_2H_4O_2 + H_2O.$$

GLYCERINE

Can be obtained in the common method by decomposing fats and oils, where it exists in combination as a product formed under the influence of vital force. It also can be obtained from inorganic compounds by a series of simple steps.

If this compound ethane, which we just saw formed from inorganic constituents, be treated with iodine, we have ethyl iodide formed, and this, with zinc, gives zinc ethyl $C_2H_6 + I_2 = C_2HI + H_2I$, $2C_2H_5I + 2Zn = ZnI_2 +$ Tu (C_2H_52). Again, if we heat CS_2, H_2S and Cu together, we have a compound (CH_4) marsh gas, formed $CS_2 + H_2S + 8Cu = 4Cu_2S + CH_4$; this, with iodine, gives CH_3I, methyl iodide; $CH_4 + I_2 = CH_3 + HI$.

These two compounds, zinc ethyl and methyl iodide, when heated together, form zinc iodide and a new compound, propane, C_3H_8, $Zn(C_2H_5)_2 + 2CH_2I = ZnI_2 + 2C_3H_8$. This, with iodine, gives propyl iodide, $C_3H_8 + I_2 = C_3H_7I + HI$, and this, with KOH, gives KI, H_2O, and another substance, propylene, C_3H_6($C_3H_7I + KOH = KI + H_2O + C_3H_6$), and this treated with Cl and chloride of iodine, gives another compound, $C_3H_6(Cl_2)$, $C_3H_6 + Cl_2 = C_3H_5Cl + HCl$, $C_3H_6Cl + 2ICl = C_3H_5Cl_2 + I_2$, which, with much water at a high temperature, is changed to glycerine, $C_3H_5Cl_2 + 3H_2O = C_3H_5(OH)_3 + 3HCl$.

When glycerine now, which we have seen built up by means of inorganic reagents from the elements themselves, is treated with HI, an inorganic reagent, it forms allyl-iodide, $C_3H(OH)_3 + 3HI = 3H_2O + 2I + C_3H_5I$, and this, again treated KSCN, which in turn is readily obtained from the elements, we have formed a new compound, $C_3H_5Cl + KSCN = KI + C_3H_5SCN$, which has the odor and general appearance of the chief constituent of the oil from the common mustard, and on closer examination proves to possess identical physical and chemical properties, the same boiling point, odor, taste, undergoes precisely the same changes with the same chemical reagents, and is in fact precisely the same substance as the natural mustard oil, but formed entirely from substances which have been obtained from inorganic constituents.

ANOTHER EXAMPLE.

We saw that by inorganic agencies we could obtain a substance, methyl iodide, CH_3I, and also that by the direct union of C and H we could obtain C_2H_2, acetylene. When this acetylene is simply heated intensely we obtain a small quantity of benzol, C_6H_6, which with bromine gives a compound, C_6H_5Br. This C_6H_5Br, together with the CH_3I treated with the metal sodium, gives a compound, toluol, $C_6H_5Br + CH_3I + Na_2 = NaBr + NaI + C_7H_8$, and this by heating gives anthracene, ($C_{14}H_{10}$). Anthracene when oxidized gives anthraquinone, $C_{14}H_{10} + 3O = H_2O + C_{14}H_8O_2$, and anthraquinone when treated with H_2SO_4 gives a new product, which finally treated with KHO and HCl gives alizarine. Now this alizarine is found to be absolutely identical with the coloring material of the madder root, in composition, properties, and chemical action. Fortunately, also, the anthracene can be obtained in quantity by distilling coal tar so that the alizarine of the laboratory is much cheaper than the alizarine from the madder root itself, and is, of course, just as good, being identical with it, so that it has nearly forced the true madder out of commerce.

OIL OF BITTER ALMONDS.

Let us now start again from the same toluol, which we

saw in the last example, built up synthetically from inorganic substances, but which is readily obtained from coal tar by distillation.

When this toluol is heated, and then treated with chlorine, we have a compound formed, the benzyl chloride ($C_7H_8 + Cl_2 = C_7H_7Cl + HCl$), and this with caustic potash gives benzyl alcohol ($C_7H_7Cl + KOH = KCl + C_7H_7OH$), by oxidation we get from this a liquid compound which has the odor of bitter almonds, and on further examination proves to be identical with the oil of bitter almonds which is obtained from the kernels of the bitter almond itself ($C_7H_7OH + O = C_7H_6O + H_2O$). It is in fact the same substance as the purified and distilled oil of bitter almonds. This artificial oil of bitter almonds is not to be confounded with the cheap nitro-benzol or essence of mirbane, which possesses a similar odor, but is by no means identical with the oil of bitter almonds, or the *benzaldehyde*.

OIL OF CINNAMON.

Again, we find that if we take this artificial oil of bitter almonds, and together with this take common aldehyde (obtained by oxidizing alcohol, which we have already seen can be prepared synthetically), and treat the two substances together with HCl, we have formed a new substance which is again identical with another natural product, viz., the chief constituent of cinnamon oil, which is formed in the bark of the cinnamon tree ($C_7H_6O + C_2H_4O = H_2O = C_9H_8$. CH : CH. CHO.

WINTERGREEN OIL.

Wintergreen oil also can be obtained very readily as a laboratory product by the action of methyl alcohol (obtained also artificially like the common alcohol from the CH_3I already spoken of, and AgOH) upon salicylic acid under the influence of H_2SO_4. Salicylic acid is readily obtained from phenol or carbolic acid by treating the sodium salt of carbolic acid with CO_2 and Na, and decomposing the resulting salts with acids $C_6H_5ONa + Na + CO_2 = C_6H_5ONa$, CO_2Na. C_6H_5ONa. $COONa + H_2O = NaHO + C_6H_5OH$. COOH.

CARBOLIC ACID.

Phenol, also, or carbolic acid, can be obtained synthetically by the action of acetylene on H_2SO_4 and fusing the potassium salt of the acid formed with caustic potash. The artificial product is in this case precisely the same as the chief constituent of wintergreen oil derived from the plant, when distilled and purified.

A couple examples more, and these, the latest, will suffice.

Let us start again from two substances whose preparations are already explained, propane, C_3H_8, and toluol, C_7H_8. When toluol is treated with Br in the cold a para-brom-toluol is formed, C_7H_7Br.

When propane is treated with Br propyl bromide is obtained, C_7H_7Br; when these two bromides are treated with metallic sodium, a new compound cymol, $C_{10}H_{14}C_3(H_7Br + C_7H_7Br + 2Na = 2NaBr + C_{10}H_{14})$, is obtained, and by the oxidation of this substance by means of sulphuric acid and potassium bichromate. Prof. Oppenheim obtained a small quantity of a substance of the odor, appearance, crystalline character, and chemical composition of common camphor, and the proof of the reaction may be substantiated by the fact that camphor treated with P_2S_5 or $ZnCl_2$ gives this same cymol.

INDIGO BLUE.

The last example which I shall call your attention to is one, the completion of which has been effected in the present year by Prof. Baeyer, of Munich, to whom, in fact, we are chiefly indebted for the earlier steps in the synthesis. Baeyer had some time ago obtained the indigo blue by the action of PCl_5 and acetyl chloride, $C_2H_{30}Cl$, on another compound, Isatin; and in the present year he has succeeded in obtaining this isatin from simpler constituents, and has finished the complete synthesis of indigo blue.

Starting from *toluol*, which we have already used in the other examples, and the preparation of which has been explained; and treating when hot with chlorine, we have benzyl chloride. This treated with KCN, and boiled with dilute acids, gives $C_7H_7CH_2$ COOH, phenyl-acetic acid, $C_7H_8 + Cl_2 = C_7H_7Cl + HCl$, benzyl chloride; $C_7H_7Cl + KCN = C_7H_7CN + KCl$, benzyl cyanide; $C_7H_7CN + 2H_2O + HCl = NH_4Cl + C_7H_7COOH$, phenyl-acetic acid; and this treated with HNO_3 gives a nitro-phenyl-acetic acid. By the action Sn and HCl on this latter compound is obtained oxindol, which, with nitrous acid, gives nitroso oxindol; this, with reducing agents, gives amido-oxindol; and this finally, oxidized with Fe_2Cl_6, or HNO_2, gives isatine. And as we have already seen, the indigo blue can be obtained from this by PCl_5 or C_2H_2OCl.

I have not attempted to give the most convenient or simple mode of obtaining these compounds; on the contrary, I have often taken the more inconvenient and expensive methods, with the one purpose of showing the possibility of producing these compounds from strictly inorganic constituents by a series of consecutive reactions. In no case has a method been used in which any reagent is employed which cannot itself be obtained from inorganic constituents. In other words, all these complex organic compounds have been obtained without any but the common and simple reagents of the inorganic laboratory.

The achievements of organic chemistry in other directions I have no intention of discussing now.

NITRIC ACID: ITS REPRODUCTION FROM THE LOWER OXIDES OF NITROGEN.

By BERNARD C. MOLLOY.*

IN treating in this short memoir of the economic use of nitric acid, it may be stated by way of preface why it is considered worthy of such attention. In the first place, it is the highest oxide of nitrogen known; and parting so easily and freely with its oxygen, it stands foremost in the list of oxidizing agents, and consequently among the most useful chemical reagents in manufacturing enterprises.

There are two drawbacks—in some cases fatal—to its use; one is the high price of the acid, the other the injurious and inolodorous gases which it evolves. The object, therefore, in the researches which have been made in connection with this subject has been twofold—first, to introduce the greatest possible economy in the use of nitric acid; and secondly, to get rid of the injurious gases. In effecting the former the latter object has been attained. To make the description of the operation more clear, it will be well to recall for a moment the several oxides of nitrogen. There are five compounds of nitrogen with oxygen, containing respectively 1, 2, 3, 4, and 5 volumes of oxygen to 2 of nitrogen—(1) nitrous oxide, N_2O; (2) nitric oxide, N_2O_2; (3) nitrous anhydride, N_2O_3; (4) nitrogen peroxide, N_2O_4; (5) nitric anhydride, N_2O_5. If water be added to the fifth, or highest oxide, we have nitric acid, thus—$H_2O + N_2O_5 = 2HNO_3$. Now, if nitric acid be used for the purpose of supplying oxygen, and if it parts with one atom of its oxygen, it becomes nitrogen peroxide; if with two atoms of its oxygen, it becomes nitrous anhydride, and so on, according to the descending scale of the oxides of nitrogen. In the same way, if with the nitrous anhydride are combined two atoms of oxygen, then it again becomes the highest oxide or nitric anhydride; while if one atom of oxygen be combined with the four atoms of oxygen of the nitrogen peroxide, then again we obtain the highest oxide of nitrogen. When, therefore, any oxidizable substance is presented to nitric acid, it, with few exceptions, parts with a portion of its oxygen, which combines with the substance to be oxidized. For example—when sugar is oxidized by nitric acid for the production of oxalic acid, the nitric acid is deoxidized by losing a portion of its oxygen, and the nitrogen is evolved, combined with the remaining oxygen as a lower oxide of nitrogen. Under the most favorable conditions, not more than 50 per cent. of the oxygen contained in the nitric acid can be used for the purpose of oxidation. In many cases the percentage is as low as 20.

If these gases of lower oxides pass away into the air, they will eventually be reoxidized by the joint action of the oxygen and the vapor of the atmosphere into nitric acid, become absorbed and carried down by the moisture to act most destructively on vegetation and all else that is capable of being oxidized by it. Moreover, a fresh supply of acid will be required for each successive operation. Now it will be evident that, if sufficient oxygen can be made to combine with these lower oxides of nitrogen, nitric anhydride will be formed, which, when combined with water will reproduce nitric acid. The difference between all these oxides of nitrogen is one only of the number of atoms of oxygen which are combined with the two atoms of nitrogen. To effect this reproduction with economy, the "means" employed must be economical. In the process about to be described, this reproduction is effected under the most economical and simple conditions. I will now proceed to describe the method employed to effect the reoxidation of these lower oxides of nitrogen, and their conversion into nitric acid—premising, however, that the details of the method may slightly vary with the conditions under which the lower oxides are produced. Taking the case above cited, viz., the production of oxalic acid, I will deal with the gases evolved during this operation. These consist of a mixture of lower oxides of nitrogen of a deep brownish-red color caused by the presence of nitrogen peroxide. These gases or fumes are conducted into towers where they are to be reoxidized. These towers consist of closed chambers about —for ordinary purposes—30ft. high and 3ft. diameter. They may be constructed of glazed earthenware pipes, or other material not easily affected by the acid. The tower rests in a reservoir or base, from which it may be drawn as produced. In the sides of the tower are fitted sight holes of bottomless glass bottles, so that the quantity of the gases may be roughly estimated by the depth of the color inside the tower. The top of each tower is of a conical form, and in the center of the cone is fixed a jet. This jet is so constructed that steam and hot water are forced out so as to be brought into contact. It is arranged so as to be capable of being easily and accurately adjusted in order to cause a cloud or spray of very finely divided water at about the temperature of 100 deg. Cent. to fall slowly through the tower. Atmospheric air is allowed at the same time to enter the tower through the jet. The admission of air and the supply of the hot water spray should always be so arranged as to be capable of being regulated at will. As is obvious, the tower should be gas tight, except as herein described.

Now, the gases or fumes coming from the vessel in which the nitric acid is being used will enter and gradually rise till the tower is charged, when the jet is brought into action. Steam and hot water are turned on into the jet in such proportions that the steam will strike and convert the water into a minutely divided spray, the steam itself being condensed in the water. Thus a misty spray only of hot water, 100 deg. Cent., falls slowly down through the tower. The tower should be packed to avoid radiation of heat, and too rapid condensation of the hot vapor. In its descent the particles of hot water come into contact with the oxides of nitrogen. The nitrous anhydride, N_2O_3, and nitric oxide, N_2O_2, are immediately oxidized by the air—admitted and drawn in through air holes or through the jet—into peroxide of nitrogen N_2O_4, thus:

$$N_2O_3 + N_2O_2 + 3\,O = 2\,N_2O_4.$$

This peroxide of nitrogen, N_2O_4, is quickly absorbed by the spray and decomposed by it into nitric oxide and nitric acid. The nitric acid is dissolved by the hot water and carried down into the reservoir at the foot of the tower. The nitric oxide remains undissolved by the spray, but it is oxidized as fast as produced by the air into nitrogen peroxide, which in turn, becomes split up into nitric oxide and nitric acid, the latter being collected as before in the reservoir. The reaction may be approximately shown thus:

$$6\,N_2O_4 + 4\,H_2O + 2\,N_2O_2 + 8\,H\,N\,O_3.$$

Eventually, therefore, the lower oxides of nitrogen become oxidized by contact with the air into the higher peroxide, and this in turn becomes absorbed by the spray and separated into nitric oxide and nitric acid, which latter is always dissolved and carried down. All these reactions being successfully continued, the whole of the original nitric acid, when used and treated under these conditions, will be reproduced. Practically all the above reactions occur simultaneously, so that nitric acid is reproduced from the lower oxides as soon as they are generated. Two or more towers may sometimes be advantageously used. The towers are connected by a water joint or valve offering but a slight resistance, so that an excess of the fumes or gases, if any, may pass into the second tower, there to be treated as in the first. The form and general disposition of the apparatus for thus treating nitric acid will naturally vary, as before remarked, with the purpose for which the acid is employed, but whatever the form be, if only proper care and attention be bestowed, the result will be the recovery of the whole of the lower oxides of nitrogen and their conversion into nitric acid.

I believe this is the only successful attempt ever made to economize the use of nitric acid to the same degree. By the means here described there is no loss, and the whole of the original acid is recovered in its pure and simple form. It seems to me that this gain should popularize the use of this powerful oxidant, and render it available for many industrial enterprises for which it is at present inapplicable. It places another powerful agent in the hands of the manufacturer and metallurgist, and renders available for many purposes a reagent which is at present limited in its application. In conclusion, I will only add that in no single instance has the process failed or even varied in the results.

* British Association.

PRESERVATIVE GASES AND VAPORS.

SUMMING up his numerous experiments in preserving animal substances, Dr. Richardson gives the following results as to the value of various gases and vapors. He says: "The best agents of the class of gases and vapors are ammonia, hydric sulphide, sulphurous acid, cyanogen, and methylal. For the perfect process of preservation, for a period of sixty days at least, all these may be accepted as preservatives which would bear any reasonable strain of heat and motion during transit from one part of the world to another, excepting, always, these accidental changes which now and then occur, and which yet remain unexplained. The four preservatives named preserve the structure of the animal substance only from decomposition; they do not preserve the color. The color can be preserved by carbonic oxide, or by a medium containing carbonic oxide, such as coke vapor or coal gas, or by oxygen in the free state. Coke vapor is, on the whole, the most ready menstruum for use everywhere, and I may add that it is quite unobjectionable in regard to communication of taste or odor. None of these are absolutely perfect. Ammonia fails because it is retained in the substance of the flesh, and gives an unpleasant taste. Sulphurous acid fails because it does not preserve for a sufficient time after the specimen is removed into the open air, and because it imparts a slight acidity, destroys the natural odor of freshly cooked meat, and conveys to a perceptible degree the idea of a meat that has been salted. Cyanogen fails for, I may say, the almost exclusive reason that it is a dangerous agent; unless it be used with the most scrupulous care it cannot be used at all. Vapor of methylal fails in that it conveys a taste, and the idea of a preparation by salting. The ammoniated and sulphureted paraffins fail because of the retention of the taste and odor of the paraffin."

ON THE REACTION OF SULPHURIC ACID AND IODINE UPON STARCH.

J. SALOMON reports that when starch is converted into dextrine and sugar by solution in dilute sulphuric acid, iodine does not produce any discoloration when the starch is entirely dissolved, and concludes therefrom that the colors produced in solutions containing both dextrine and starch are caused solely by the presence of the latter, and are in no way connected with the dextrine. As soon as all the starch is converted, the deviation of dextrine in the polariscope is found to decrease with dilute acid about one-half and with concentrated acid to one-quarter of the former angle. The process of saccharification is considered by the author as analogous to the formation of ether, the quantity of sugar formed within a given time advancing with the concentration and the quantity of the acid. In the solutions obtained, the author has found a peculiar acid, forming a soluble salt with baryta, of which the author promises to furnish further particulars soon.—*Chem. Notizblatt.*

A NEW ORGANIC BASE IN ANIMAL ORGANISMS.

AT various times during the last twenty-five years observers have called attention to and described some peculiar crystals which are to be met with in certain organs of the animal body, as well as in such fluids as blood, saliva, pus, etc., both in health and disease. Charcot, in 1853, was the first to direct attention to them, and hence by many authors they are spoken of as "Charcot's crystals." By some they have been supposed to be tyrosine, by others, phosphate of lime, and by others again, a compound allied to albumen. Professor Schreiner has recently shown that they are the phosphates of a new base entirely. The pure substance has marked alkaline properties, and forms little groups of crystals resembling wavellite. It dissolves in absolute alcohol, and is only slightly soluble in ether. When heated with a solution of potash or soda it evolves ammonia, and it gives a flocculent white precipitate with chloride of zinc. A second paper on the subject by the author will shortly make its appearance.

NEW METHOD OF TREATING REFUSE IRON OXIDE FROM GAS HOUSES.

LARGE quantities of hydrated oxide of iron are used in gas factories for purifying gas, and are generally considered valueless after having become impregnated with the various impurities of the gas.

Spence proposes to treat the oxide in the following manner to render it fit for use again.

The oxide is first washed out with water to free it from ammonia. It is then dried in the air, mixed with one-half of its weight of dry slaked lime, and lixiviated by water of about 125° F. The solution is now slightly acidulated and then mixed with a solution of chloride of iron. The result is a precipitate of Prussian blue, which may be used as a pigment or converted into ferrocyanide for use in the arts. The remaining mass is boiled with water, a solution of calcium sulphides being the result. This is treated with muriatic acid, by which a solution of chloride of calcium and precipitated sulphur are produced.

The remaining iron oxide is now fit for use again.—*Deutsche Industrie-Zeitung.*

ARTIFICIAL CARLSBAD SALTS.

ARTIFICIAL Carlsbad salts, keeping well and dry, may be prepared as follows: Two pounds of chloride of sodium are dissolved in ten pounds of water. The solution is heated to 48° F., while twenty-five pounds of sulphate of potassium and three pounds of bicarbonate of soda are gradually added. The solution is filtered and allowed to crystallize. The decanted mother liquor is again saturated with sulphate of sodium, and allowed to crystallize. The crystals are collected, drained and dried at ordinary temperature. When kept in well closed bottles, they keep in the shape of colorless crystals for a great while.

ACTION OF IODIC ACID ON STRYCHNINE.

SELMI reports the following reaction of iodic acid on strychnine. When strychnine is moistened with a solution of iodic acid in sulphuric acid, it turns yellow, then brick red and lastly violet. This is of some importance, as iodine preparations act similarly on morphia, and that reaction has to some extent been considered proper to the latter alkaloid only.

SOLUBILITY OF PLATINUM IN SULPHURIC ACID.

In preparing smoking sulphuric acid, Kestner found that the platinum, of which the retort consisted, dissolved rapidly in the acid; the proportion of eight grs. to the pound was determined by analysis. In concentration boilers for ordinary sulphuric acid, the proportion of platinum soluble in a ton of acid varies between eight and sixty grains, just according to the degree of concentration of the acid. The solubility depends greatly upon the area of surface exposed to the action of the acid, but even in the most unfavorable case this could not account for the solution of two pounds of platinum to a ton of acid, as above stated. No reason has as yet been assigned for this abnormal behavior of platinum.

PRESERVING WOOD.

Hatzfeld recommends, in *Eisenbahn*, for this purpose the injection of tannic in form of decoctions of substances containing it, as for instance, chestnut and oak bark. The wood is treated with these decoctions in closed vessels at high pressure, and afterwards treated with a solution of the pyroacetate of the sesquioxide of iron. The latter is transformed into a tannate and finally converted into a salt of the oxide by oxidation. This process has now been generally introduced by the larger railroad and telegraph companies in France.

SUGAR REFINING BY CHLORIDE OF BARIUM.

Sugar may be readily refined by the following process. For each 100 pounds of sugar in solution 64 parts of chloride of barium are added to the latter. A quantity of caustic soda in solution, corresponding to the quantity of barium chloride used, is now mixed with the saccharine liquid, when the sugar will be precipitated in combination with the baryta. This compound is now decomposed by carbonic acid, and the clear, refined sugar may now be obtained from its solution, carbonate of baryta having been formed as an insoluble white precipitate.—*Pharm. Centralhalle.*

PLATINUM BLACK.

An excellent quality is obtained when a solution of platinum chloride is boiled with rochelle salts. The metal is precipitated while carbonic acid is violently developed. The precipitate must be well washed out and dried at moderate temperature. For covering metal vessels for chemical purposes with platinum (by the electric current), a solution of platinum chloride in citrate of sodium is recommended.

PROCESS FOR SULPHURIC ACID.

The following simple process for making anhydrous sulphuric acid has been introduced by a german chemist, Dr. J. A. W Wolters.

The first step in the manufacture is the production of anhydrous bisulphate of sodium. This is made by heating glauber salts with an excess of sulphuric acid to the melting point. The sodium bisulphate is then fused together with anhydrous magnesium bisulphate in a retort. The magnesium salt is hereby decomposed, and anhydrous sulphuric acid becomes liberated and distills over. From the mixture of sulphates and bisulphates remaining, the magnesium and the sodium salts may be obtained by crystallization as their respective degrees of solubility vary greatly. They may then again be treated as above, and used again for producing anhydrous acid. As the heat required for this process is not very great, a larger variety of materials may be used for making the retorts than when the old process is followed. —*Deutsche Industrie Zeitung.*

BENZOIC ACID FROM NAPHTHALINE.

Benzoic acid is now largely manufactured from naphthaline. This is converted into phthalic acid. This is treated with slaked lime. Phthalate of lime is formed. When this is heated with an excess of lime to above 600° F., a mixture is formed, consisting of benzoate and carbonate of lime, from which the benzoic acid may be easily separated. Phthalic acid may also be prepared by synthesis from salicylic acid and carbonic oxide, from resorcine and carbonic oxide, or from resorcine, salicylic acid, and oxalic acid.—*Chemiker-Zeitung.*

ORIGIN OF THE METALLIC IRON OF GREENLAND.

Since Nordenskjöld discovered the deposits of metallic iron in the basalt formations of Greenland they have generally been considered as of meteoric origin. Among those advancing that theory were Nanckhoff, Lindström, Daubrée, Wöhler, and others, while the meteoric origin was doubted only by few like Steenstrupp, Johnstrupp, and, later, J. L. Smith. The latter has now, by the kindness of the royal museums of Stockholm and Copenhagen, been enabled to study the subject extensively, and comes to the following conclusions: The basalt formations penetrate the coal formation and other strata rich in animal and vegetable fossils. There is a marked difference between meteoric iron from other places and the deposits inclosed in Greenland basalt. The iron is so embedded and sometimes penetrated by particles of the basalt, that it is impossible to regard it as anything else but a portion of the latter, formed probably, while the basalt was yet in a liquid state, by the reducing action of vegetable matter of the surfacial layers it penetrated.—*Chem. Notizblatt.*

THE LATEST ADVANCES IN FRUIT CULTURE.

The twenty-fourth annual meeting of the Western New York Horticultural Society was held in Rochester, January 22, 23. The sessions, lasting until late Thursday evening, were very interesting, and many valuable facts were elicited. The past year has been scarcely less depressing to fruit growers than to other industrial interests, and the outlook for the production of any excepting the very best fruit is not encouraging. Many thousand barrels of apples have been allowed to waste; but, on the other hand, fruit carefully grown, closely selected and honestly put up, has been marketed at a reasonable profit.

The lesson of 1878 is that while low prices prevail, none but the choicest fruit can be sold successfully. At the same time low prices are introducing American fruit in markets where it has never before been seen. If we can maintain a high standard of excellence, and afford to sell cheaply, that demand shall continue to increase. Much may also be done to extend our home market, increasing the use of apples, and providing for disposing of second and third class fruit for drying and for cider.

APPLES.

The cheapness of apples has given an impetus to drying this fruit. Subjecting the sliced fruit to the fumes of burning sulphur is warmly recommended as the best means of bleaching it. This also prevents decay in drying and makes the dried fruit salable at a higher price. Bleaching the fruit is done by burning sulphur, or brimstone, under baskets piled over each other in a long, deep box, so that the fumes in rising permeate the fruit thoroughly. With a properly prepared light box this is easily done, and at very slight expense. Some large establishments use up hundreds of bushels of apples daily, buying them at 12 to 15 cents per bushel, which will make from 5½ to 6 pounds of dried fruit of superior quality. The drying is done in large evaporators, heated by a furnace beneath. In some cases hop houses have been successfully used after the hop season was passed.

NEW FRUITS.

The new fruits of 1878 embrace a list most extraordinary, both in number and value. While apples, plums, and cherries have shown no change of moment, we have fully thirty new peaches, some earlier than any before known, and all promising to be remarkable acquisitions. They need further testing, but in this list we can scarcely fail to get superior fruit. Mr. William C. Bang's paper on the new fruits of 1878, and fully describing these new peaches, is of great value. We have four new white grapes tested this year, but not all ready to send out. The Prentiss has been in bearing fifteen years on the grounds of its originator, for whom it was named, and has proved hardy and productive. Quality superior. It is being propagated by T. S. Hubbard, of Fredonia. Mr. Charlton, of Rochester, exhibited specimens of the Packington, a very promising white grape. Mr. Hoag, of Lockport, has a new white grape, the Niagara, which, as a seedling of Concord, has all the virtues of hardiness and vigor of its parent, with flavor superior to Martha, Lady, or any other known Concord seedling. Something was also said commendatory of the Duchess, a white grape which originated on the Hudson, but is proving its value in other sections of the country.

PEACH GROWING.

Probably the chief feature of the discussion was the general interest manifested in peach growing. This fruit is going to be much more largely planted the coming year. Mr. Younglove gave a very interesting description of his mode of training and thinning the fruit. He cuts back in early spring, causing a strong growth of new wood for next year's fruiting. When the young peaches are as large as cherries he thins out, leaving the peaches five or six inches apart on the limbs. He always aims to thin so that the branches will never be in danger of breaking with the weight. This vigorous thinning largely increases the size of the fruit and entirely transforms its character, making it rich, juicy, and melting. This fruit sells itself without difficulty, while peaches grown without thinning are a drug at low and unsatisfactory prices. An equally important result is the greater vigor of the trees. The pulp of fruit, which is its most valuable part, does not exhaust the vitality of the trees nearly so much as the production of a large number of half-formed specimens of little value. Thinning peaches is a preventive of rot in such varieties as Hale's Early, which are subject to that complaint. The trees set too much fruit, and in failing to perfect it the fruit rots, as also the twigs on which it grew. The thinning is much less labor than would be supposed, one grower saying that it was fully saved in the increased facility of picking large, perfect fruit when ripe. The thinning must be done before the stone is formed or the fruit will largely impair the vitality and vigor of the tree. A few varieties do not need thinning, the Late Crawford generally thinning itself sufficiently. Early varieties, as a rule, most need thinning, and no work will pay better. This is true not only of peaches but of grapes and pears.

THE PEACH BORER.

With regard to the peach borer, a solution of soft soap, with an equal amount of water, swabbed on the trees and about the roots, is an effectual preventive. A little carbolic acid will make the mixture more offensive to the miller that lays the borer eggs, and will cause a more lasting effect. Some damage has resulted to newly set peach trees from the effect of raw ashes applied around the roots in burning the tender bark. Leached ashes are probably better than unleached and coal ashes, though much poorer in mineral elements, will always answer a good purpose. If the peach tree borer has effected a lodgment, he must be cut out. The same is true of the apple tree borer. The latter owes its origin to a beetle, and is not so easily guarded against. Ashes or soap suds are not always effective in preventing the apple tree borer beetle from laying its eggs. Carbolic acid is useful, though besides all a sharp watch must be kept, and the enemy cut out. There were some fears expressed that the dreaded disease, the yellows in peaches, had appeared in Western New York; but it is hoped that severe cold in the winter of 1875, and other causes enfeebling the vitality of the trees, are the explanation of partial failures of this crop. The orchards set since 1875 are generally exempt from disease.

GRAPES.

Grapes will ripen earlier when one or two of the bunches on each spur are pinched off. The prevalence of mildew on many hardy varieties of grapes is due to overbearing. The grapes set more thickly than the vine can perfect, and grow until the berries are nearly full size. Then the vine is unable to perfect the seeds, and the bunches hang for days without making any progress, and are often never ripened. Thinning at this late period will do little good. The injury has already been done. Such vines will make a feeble growth, the leaves and fruit will mildew, and the vine be enfeebled for years. When growers of new varieties boast that they let grape vines grow without thinning the fruit, and without mildew, they boast of what they should be ashamed of. No vine, however vigorous or hardy, should be subjected to such a test.

THE CODLING MOTH.

Our knowledge of the codling moth, and methods of fighting it, has not made much progress the past year. The paper bands, carefully applied and well watched, generally save the crop. Some experiments indicate that two bands around the tree are better than one. Old trees must have rough bark scraped off before applying the bands, or they will do little good. It is worth trying whether it will not pay to apply the bands earlier than we have been wont, and destroy the moths that take refuge under them before any worms have hatched. The codling moth does its work by night, and if the bands are daily examined just after blossoming time, a good many of the females may be destroyed. One miller killed in May is better than a hundred worms destroyed in July or August, after much of the mischief has been done.

STRAWBERRIES.

The number of new strawberries forced in 1878 is very remarkable, and several are extremely promising. Crescent Seedling will probably prove a standard sort. It is especially the lazy man's strawberry, which fits it for an immense parish, and is also adapted to the millions of farmers who are not lazy, but cannot easily find time to give strawberries the perfect culture which many varieties need. Of other new sorts the Sharpless is a very superior fruit, and enormously vigorous and productive. It will bear poor culture, but, like all strawberries, succeeds better with good care. Of other comparatively new sorts, Jack, Col. Cheney, Cumberland, Triumph, and Kentucky all promise well. Windsor Chief is remarkable for beauty, high quality, and productiveness. When thorough culture is given, there is much advantage in removing part of the later berries, which are usually of little account in marketing.

BEST PLUMS.

The best plums for market were named as follows: Reine, Claude De Bavay, Lombard, Pond's Seedling, Tellemberg or Italian Prune, Bradshaw, Coe's Golden Drop, Shropshire Damson, Mooney, German Prune, and Yellow Egg or Magnum Bonum. The Monroe Egg or Monroe Gage is a popular local variety near Rochester, valuable chiefly for its great productiveness and popularity for canning establishments. It is only second quality, but for canning dealers will take a poor white or green plum rather than a first quality dark plum.—*American Cultivator.*

ANOTHER NARCOTIC PLANT.

Major Stuart, writing from Port-au-Prince, notices a plant growing there of such strong narcotic power that, in the hands of a skillful practitioner, it will produce coma of any intensity or duration, or even death itself when so intended. The knowledge of this plant, he says, is confined to a few families, who transmit the secret as an heirloom from generation to generation, and the heritage is highly valued, confirming, it is thought, the power of miracle-workers and priests—for the plant is in many ways useful in aid of solemn imposture, superstition, and crime. The power thus exercised is called "wanga," a word that inspires the African with awe and dread. The wanga priest can throw into a death-like coma, and, knowing the moment of consciousness returning, he will make a show of recalling to life; or, if a burglary is to be committed, he can, by means of his art, cast a deep sleep on his victims. Major Stuart thinks that this plant would prove a valuable acquisition to medical science.

INDIAN NUT PARTIES IN NEVADA.

Approaching a Nevada mountain a low brushy growth is seen, strangely black in aspect, as though it had been burned. This is a nut-pine forest, the bountiful orchard of the red man. No slope is too steep, none too dry, every situation seems to be gratefully chosen, if only it be sufficiently rocky and firm to afford secure anchorage for the tough, grasping roots. It is a sturdy, thick-set little tree, usually about fifteen feet high when full-grown, and about as broad as high, holding its knotty branches well out in every direction in stiff zigzags, but turning them gracefully upward at the ends in rounded bosses. It is pretty generally known that this tree yields edible nuts, but their importance and excellence as human food is infinitely greater than is supposed. In fruitful seasons the pine nut crop of Nevada is, perhaps, greater than the wheat crop of California, concerning which so much is said and felt throughout the food market of the world. The Indians alone appreciate this portion of nature's bounty, and celebrate the harvest time with dancing and feasting.

Inasmuch as the cones require two years to mature from the first appearance of the little red rosettes of the fertile flowers, the scarcity or abundance of the crop may be predicted more than a year in advance. Squirrels and worms and Clark crows make haste to begin the harvest. The Indians make ready their long beating poles; baskets, bags, rags, mats are gotten together. The squaws, out among the settlers at service, washing and drudging, assemble at the family hut; the men leave their ranch work; all, old and young, are mounted on ponies, and set off in great glee to the nut lands, forming cavalcades curiously picturesque; flaming scarfs and calico skirts stream loosely over the knotted ponies, usually two squaws astride of each, with the small baby midgets bardaged in baskets slung on their backs or balanced upon the saddle bow, while the nut baskets and water jars project from either side, and the long beating poles, like old-fashioned lances, angle out in every direction. Arrived at some central point already fixed upon, where water and grass are found, the squaws with baskets, the men with poles, ascend the ridges to the laden trees, followed by the children; beating begins with loud noise and chatter; the burrs fly right and left, lodging against stones and sage brushes; the squaws and children gather them with fine natural gladness; smoke columns speedily mark the joyful scene of their labors as the roasting fires are kindled; and at night, assembled in circles, garrulous as jays, the first grand nut feast begins. Sufficient quantities are thus obtained in a few weeks to last all winter. They also gather several species of berries and dry them to vary their stores, and a few deer and grouse are killed on the mountains, besides immense numbers of rabbits and hares; but the pine nuts are their main dependence—their staff of life, their bread.—*Letter to the San Francisco Bulletin.*

SOWING SEEDS.

Every year complaints appear in the papers about seedmen selling bad seeds. The seeds are sown, and not growing well they are set down as having been bad when sold. This carries an absurdity on the face of it. Most of our large seed dealers have to live on their reputation; the better they are known the more business they do. Like all other enterprising tradesmen, they want to extend business from year to year to do this, and the only way to do is to sell seed that grow well, and on which they can build a business reputation. If they sold seed that would not grow their business would go back instead of forward. No doubt there are some among them who would sell bad seeds, short-sighted as it would be, for there are fools in all pursuits, but it cannot be that many do this. But seeds often do not grow, not because they are bad, but that they are

badly treated, and one of the worst forms of bad treatment is deep sowing. To be barely covered, and yet pressed in tight to the earth, in rather dry soil, is the essence of first-class seed sowing. But many people have so firm a belief that seeds are mixed good and bad together, that they sow more than they want, and then have to spend labor on thinning out if there should chance to be more come up than they need. But, if they are properly sown, there need be no more put in than are wanted, and of vegetable seeds the following are about the quantities:

Asparagus, bed of 15 sq. yds.	1	pt.
Beans, broad, row 80 feet	1½	qt.
Beets, row 50 feet	2	oz.
Broccoli, 4 sq. yds	1	oz.
Brussels sprouts, 4 sq. yds	1	oz.
Cabbage, bed of 8 sq. yds.	1	oz.
Carrots, drill of 120 feet	2	oz.
Carrots, bed of 12 sq. yds	2	oz.
Cauliflower, 4 sq. yds	1	oz.
Celery, 4 sq. yds	1	oz.
Cress, 3 sq. yds.	2	oz.
Endive, 4 sq. yds.	1	oz.
Kale, 4 sq. yds.	1	oz.
Kidney beans, row 80 feet	1	qt.
Leek, 2 sq. yds	1	oz.
Lettuce, 4 sq. yds	2	oz.
Mushroom, 7 sq. yds.	1	bu.
Onions, 9 sq. yds.	2	oz.
Parsley, row 80 feet	1½	oz.
Parsnip, drill of 200 feet	2	oz.
Peas, early, row 60 feet	1½	pt.
Peas, large, late, row 80 feet	1½	pt.
Potatoes, row 30 feet	½	pk.
Radishes, 4 sq. yds.	1½	oz.
Savoy, 4 sq. yds.	1	oz.
Spinach, 10 sq. yds.	2	oz.
Spinach, drill of 120 feet	2	oz.
Turnips, 4 sq. yds.	1	oz.

—*Philadelphia Press.*

THE WAR WITH INSECTS.

THE familiar talk of Dr. Jabez Fisher, of Fitchburg, before the Massachusetts State Board of Agriculture, at Hingham, was just such talk as farmers need.

The first insect noticed by Dr. Fisher, in his lecture, was the Colorado potato beetle, *Doryphora decemlineata*, or ten lined beetle. Its habits are now too well known to need description here. The means of destroying him are at present of the first importance. The doctor had tried many experiments, but had found nothing so cheap or effectual as Paris green mixed with plaster, and sprinkled over the vines during the growing season. One pound of green may be mixed with two hundred pounds of plaster, and be just as destructive as if but half the plaster or less were used. The main point is to get the insects to eat of the poison, a little being as sure to kill as much. In mixing the plaster with the green, he is careful to cover the nose to prevent inhaling the poison; then, by pouring a quantity upon a sheet or other close woven cloth, and letting it roll over upon itself, raising first one edge of the sheet and then the other, he has been able to mix the materials very evenly. Simply stirring in a dish is not a thorough method of mixing. Hellebore and some other poisons will destroy the insects, but the expense is one hundred times greater, while the danger from poisoning is no less to the individual applying it. The application need not be made more than two or three times during the season under ordinary circumstances.

In the vineyard he had been somewhat troubled by a steel blue beetle, *Haltica chalybea*, or grape vine flea beetle, an insect that appears early in spring, and amuses himself by eating out the center of the buds of the vine, at the same time laying eggs for a crop of brown slugs, which, in turn, consume the foliage. As the beetles are found in spring most on the outer rows, hand picking, if well followed, will check their ravages, but the work must be done early in the morning while the beetles are less active than at midday. The tent caterpillar which builds its house in our apple trees, though often doing an immense amount of damage when neglected, is one of the most easily managed insects with which the orchardist has to contend. Go over the orchards when the young caterpillars are just coming from the eggs and beginning to spin webs from their nests, and a single stroke of the finger drawn across the nest will roll them out of existence. When they first hatch, a whole colony of two or three hundred may be crushed between the thumb and finger, leaving hardly a stain.

The eggs of the apple tree borer are laid in June and July, and the larvæ are easily destroyed during the first summer, while their work is confined to the bark. After they enter the wood they may be reached by cutting or by inserting a wire, but he had found a piece of whalebone ten inches long, whittled to a point, the best thing to follow them in their crooked paths up the trunk. The rose bug had been a serious enemy to contend with on his grape vines. They also swarm in clover and hay fields, but do most injury to grapes while in bloom, eating the blossoms clean from the future bunches, and thus entirely destroy, in a single hour, the work of a whole year. Here, too, hand picking seems to be the only practicable remedy. He is most successful in destroying them by going through the vineyard early in the morning, and with a dish of water held beneath the bunches, giving the bugs a gentle tap, when they roll up their legs and tumble into the water. Of course it is constant vigilance that wins in this as in most other endeavors in life. The curculio, the doctor believes, is a blessing, as his work is chiefly performed while the fruit is young and is hanging too thickly on the trees. The insect helps the farmer to thin his fruit, but if allowed to become too numerous they may also become our enemies.

The forest tree caterpillar, or fall web worm, which attacks the apple, pear, and cherry trees, must be destroyed by searching early and often till their season is past. If taken as soon as hatched, only a few leaves will be injured, but if let alone, whole limbs with their fruit will be rendered worthless, for fruit cannot grow and ripen without leaves. The codling moth, which causes so much wormy fruit during harvest and through the winter, is an enemy every time, as most of his work of thinning fruit is done too late to help the remaining portion of the crop. This year this insect has attracted but little attention, because there was so great an abundance of fruit that there were not enough worms to go round. The apple crop being extremely light last year, very few of these insects were produced. Next year, with a small crop of apples we shall find more worms than fruit, as it has been a good year this season for raising the moths. The codling worm moth is, though small, a very beautiful insect. They may be found in spring on the inside of cellar windows, where apples have been stored. Their pupa cases may also be found in the crevices of boxes or barrels that have contained apples, and they may be found abundantly, too, under the rough bark of the trees near where they were reared. Scraping trees at the right season will destroy a great many. The best method he had discovered for trapping this insect is to wrap the trunk of the trees with loosely folded paper, which invites them to form their cocoons therein, and whence they may be removed weekly. In his own orchard he had fifty-seven trees which were treated in this way the past summer, the chrysalides being destroyed every Monday morning. The first week, on the 22d of July, he found less than a hundred, but later he sometimes found as many as two or three hundred. During the season he trapped, in all, 2,132 which were counted, and probably as many more not counted, each of which might lay thirty eggs next year, thus checking much mischief for the coming season. He had 175 barrels of good, sound fruit the past summer and autumn, all free from insects, and insects enough have been destroyed to save 120 barrels of apples from being attacked next year. That being the case, it would seem that such work pays.

With all the help of the curculio, he still finds it necessary to thin his fruit artificially, and he showed a little instrument shaped like the fork in the handle of a tack hammer, which, being inserted in the end of a long pole, is used for twisting off the surplus apples and pears. His rule for thinning is to take off every specimen that is wormy or in any way imperfect, then to reduce all clusters to a single specimen, and finally, to cut out from one-half to three-fourths of what remains, and this is the hardest thing to do of all. Pears should not be nearer than six inches apart on the tree, if one would obtain the finest and largest quality of fruit. Young trees, especially, should have their fruit thinned very close, particularly where they are not making much wood. Allowing two or more specimens of apples or pears to touch each other, invites the codling moth to deposit its eggs where the fruit touches, as it is then better protected from accident.

There were many other insects of which he might say something, but as he had designed to discuss only such as he had become personally familiar with, he would not enlarge. In answer to a question, the speaker said that the quince tree borer was similar in its habits to the apple tree borer, but was another species. They should be destroyed in the same way as given for destroying the borer of the apple tree.—*N. E. Farmer.*

THE FLORIDA ALLIGATOR.

A CORRESPONDENT of the Boston *Commercial Bulletin*, now in Florida, writes as follows:

An alligator moves much easier in a straight line than any other; if attacked by one it is a good plan, in case of danger, to run in a circle; this confuses and delays the creature, and much increases the chance of an escape. But few cases of injury to men or domestic animals by Florida alligators are on record, or known, so far as I could learn. Men, women, and children have little or no fear of them, at least of none except the largest. They are attacked and killed in every direction, and in all manners, usually being left a prey to the buzzards or other feeders upon carrion. They do not decay rapidly, even in the hot sun; their thick skins repelling the beaks of buzzards at first, and their tough fibers fighting dissolution at every stage.

I was much impressed with the alligator. He seemed to me an object worth study and observation. I had not happened to come across in my reading of natural history, sufficiently clear accounts of him, and while in Florida I lost no opportunity of gleaning information from any source likely to prove correct that would throw light upon his structure or habits. The female builds her nest in the spring of the year; she makes it of mud and leaves, banking it up in some secluded space open to the sun, depositing her eggs in layers, leaving them to hatch by the heat engendered by fermentation added to that of the sun.

Eggs to the number of 150 have been found in these nests; their shells are quite hard, in shape they are elongated somewhat in comparison with a hen's egg, and both ends are more nearly alike. In size they are usually above those of a turkey. The young break the shell, and emerge from their oozy birthplace to find a home in shallow water, where they are partially protected and cared for by the female parent until grown of a certain size, when they are obliged to look out for themselves, or their formerly fond mother will make a meal of them. The male parent is always fond of young alligator, and if it were not for the mother's protection, the alligator census would be small indeed.

YOUNG ALLIGATORS.

The little fellows are very lively, and their heads have a queer resemblance in expression to that of a bull dog. They are about six inches long on their first arrival, and are in color black, speckled with regular slashes of dirt yellow. The regularity or rapidity of their growth is difficult to ascertain. They can remain dormant for long periods, and can live without food an incredible length of time. At the hibernating season they sometimes swallow pine knots, or even stones, probably for the purpose of keeping their stomachs distended, and disgorge on resuming a more active life. I have seen alligators of all sizes, from six inches to at least fourteen feet in length, with corresponding weight, but nothing is known whereby their age might be approximately determined.

The number or length of times when growth has been suspended being unknown, renders the problem of age one of difficult solution. I believe they have a chance to grow as long as they live, and that they live, if in favorable circumstances and are let alone, an incredible number of years. Why should there be a natural period to their existence? They shed their teeth every year; no matter how large the animal is, the same process is ever going on, a new tooth is always coming forward to supplant the old. They cast their outward skin, and are found sparkling in their brightness after the old skin is thrown, even when they are of the very largest size.

No dead alligators are seen save those destroyed by violence; there is nothing that feeds upon them except in their infancy; they go on, on, on, the gristly scales of their youthful years turning in time to plates as hard as ivory, their little teeth changing from time to time until they are as large as a man's thumb; years come and go, and, undoubtedly, centuries come and go, and still the alligator of superior luck lives on, Lord knows how long, every year becoming more hideous in visage, and better calculated to impress the ignorant with a superstitious awe.

HARD TO GET ACQUAINTED WITH.

There is a feeling, difficult to describe, that comes over one while near a live alligator; the intensity of his gaze, if his eyes are open; the sleepy wise, the sleepy cunning of his expression, when his eyes are closed—he seems to know who you are and what you are thinking of; he seems to be conscious of some secret power over you; the state of deathly quiet he generally assumes has a strange fascination—this, when he is upon land, stretched before you. In the water he is more alert. The hunter moving in his boat upon the glassy waters will see just raised above the surface the bright eye and the extreme tip of the black nose of the alligator; these make two well defined points, the eye being much the largest. If alligators are plenty, the hunter or fisherman sees these points, far and near, around him. If he approaches one of these curious amphibious sentinels, no Parisian gallant can make a more graceful retiring bow than is given the occupant of the boat. The alligator inclines his head with an ineffable grace, sinks without the slightest ripple, and seems to say, "Farewell! sweet friend, adieu! but come again."

And so it will be with all these dots upon the water if visited in their turn. The boatman will find himself surrounded by alligators, in a moment they are gone; he waits, or he whistles; up come the heads again, and if he wishes to shoot, he has to decide quickly, select his game, aim at the eye, and pull the trigger. If the ball does not glance, but strikes to the brain, the alligator, with a whirl, throws himself on his back and sinks at once, mayhap never to rise again, but if he comes up he is uncertain in his movements, and the hunter is more apt to lose than to get him. Thousands killed in this way rot on the bottoms of the lakes and rivers of Florida. There was a time when their skins were in demand for leather, which was made into boots and traveling bags, but this leather is not now so fashionable, and the alligators are disturbed less than formerly. It is not an easy task to skin one, and to tan the hide so as to preserve the characteristics and color, is, I believe, almost impossible. I would have been glad of a skin tanned in this manner, but found the attempt would be expensive, with a probability of an unsatisfactory result.

I packed an alligator's leg in salt, and after a week or so took it out, intending to repack it; it looked as fresh to the eye as when first put away, but a slight handling removed the outer skin, the only thing I cared to preserve, and left the leg with a soft, beautiful skin like a baby's, which retained all the markings of the outside covering. An alligator's head bears a strong resemblance in shape to an ordinary round-toed shoe without the heel. This resemblance is very marked in alligators of medium size. The eyes are close together on what corresponds to the instep of the shoe, while the nostrils are at the extreme end and top of what might be called the toe. The eyes are of a blackish gray, with a longitudinal slit for the pupil, and are very peculiar in their expression.

The ears are just back of the eyes, and are a marvel in some respects. To an ordinary observer, and even a close one, the ear of an alligator would not be discovered. By taking a knife and experimenting a little, the flesh will be found to lift up on the point of the knife at the place above mentioned, and one can see the ear, quite capacious, of a beautiful pearly color, with a transparent membrane, very tough, stretched over a large tunnel leading directly to the brain. Their sense of hearing is very acute. Alligators can be made to rise from a river's bottom by slight noises, like the squeaking of a pig, or a low whistle. The creatures seem to have no little curiosity, and take considerable risks to satisfy it, though they are not conscious of the dangers they court.

AN OPEN COUNTENANCE.

The alligator's mouth opens quite the whole length of his head; both jaws move, a bony arrangement at the sides of the mouth limits the extent to which it can be opened. When opened, there is much inside to excite curiosity. In the first place, the tongue is mainly adhesive to the lower part of the mouth; the back part of the tongue has a very marked and curious semicircular ridge, very well defined, that serves, with a slight muscular contraction, to completely close the entrance to the gullet. An alligator can rush around in the water with its mouth wide open and not swallow a drop. The teeth are of different sizes, large and small at intervals, those in the upper jaw shutting outside the under, and those below fitting in cavities above; the large, lower forward teeth in very old alligators perforate the bones of the upper jaw on each side of the nostrils, making holes that one can push a finger through. The mouth of an alligator is singularly clean, of a pearly pink color, and the teeth, when they are new, are very beautiful and have also a pinkish cast.

The average alligator is longer from the tip of his tail to a point on his back between the juncture of the hind legs than he is from that point forward to his nose. His tail is his great engine of locomotion, and his main reliance in offensive and defensive war. I was told by one, long familiar with his habits, that with a flirt of his tail he struck his prey toward his mouth, which opens at the time and closes with a snap on whatever is thrown into it. My informant went so far as to say that the alligator sometimes in this way bit off the end of his own tail. Many are found with part of the tail gone; these may be lost in mutual fights, or perhaps by the nip of a shark, yet from what I have seen of the lightning like lateral blows given by these reptiles with the tail, I am prepared to believe the story of their self maiming.

The alligator's fore legs are considerably smaller than the hind ones, and have five toes, webbed half way up; the hind feet have but four toes, similarly webbed. The lower part of the body is of a greenish yellow, varying a little in different specimens. The flesh of this reptile is edible, and the best pieces are from the tail. I partook of some that was broiled; it was tough and fishy in taste, but far from being the worst thing a man could eat. I conversed with those who had eaten of this kind of meat often, and properly dressed pronounced it very good.

WHAT THE ALLIGATOR EATS.

The diet of the alligator is in a great measure fish. One I dissected had his stomach filled with fiddler and other crabs. Small ones eat bugs and worms, while the very largest eat pigs, dogs, calves, and possibly small negroes, as an occasional change from a fish diet. The viscera of an alligator is exceeding tough, corresponding in that respect to the exterior of the animal. The pictures that one sees of these amphibious monsters are strangely incorrect in detail, almost always. Of course, nobody could mistake what they were meant to represent, but the feet are often short of toes, the joints of the legs incorrectly placed, the tail made too round and otherwise incorrect; the curves of the mouth generally wrong, the shape of the head and position of the eyes badly rendered, and in carvings made in Florida the same faults I noticed in no small degree. The most correct one I ever

saw was on a cane, owned by a negro, who refused to sell it, as it was a present from the artist.

I made a pencil drawing of an alligator, fresh from the water, four feet and seven inches long; my sketch was on a scale of one to eight. I took great pains to be correct and was more successful than I expected. Careful drawings from nature are the only ones to be relied on. The brain of the alligator is very small, the one above mentioned, drawn by me, had scarcely a thimbleful of brains.

In speaking of the eye, I omitted to mention that there is a nictitating membrane, or second eyelid, transparent, enabling the alligator to protect his organ of vision from water or insects.

THE "BRAIN IVORY" OF FISHES.

COMPARATIVELY little attention has been paid by ichthyologists, in their investigations of the anatomy, physiology, and habits of fishes, to the auditory apparatus of these animals. Fishes, especially those that inhabit deep seas, are so far removed from human ken that it is nearly impossible to gain any definite knowledge of what they do in the ocean depths.

Mr. Frank Buckland, therefore, suggests that fish culturists should begin to study the ear bones of fishes as helps to ascertain their habits, and his remarks on this subject form a very interesting communication to *Land and Water*. In order to understand the auditory apparatus of fishes, we must go back a step.

Mammals, birds, etc., living in air, receive impressions of sound by means of air vibrations; fishes, on the contrary, must receive any such impressions though the medium of the water. Consequently we find that the Creator has given to animals an ear admirably suited to the conditions under which they live. The human ear, for example, is somewhat complicated; sound causes the vibration of a delicate membrane, called the tympanum, and these vibrations are communicated by three small bones, resembling objects in daily use, and therefore named the *malleus* (hammer), *incus* (anvil), and *stapes* (stirrup). The sounds are collected by an external ear, with which are connected muscles that serve to move it, in certain animals. To fishes, external ears would be useless, and merely prove a hinderance.

Yet these animals have bones in their ears, and these are of a very beautiful character. The celebrated John Hunter tells us that the organ of hearing in fishes is placed on the side of the skull, or brain cavity; but the skull forms no part of it, as in quadrupeds and birds, the organ being a detached and distinct part. It varies considerably in different genera, but consists in all of three curved tubes, which unite one with another. The whole organ is composed of a kind of cartilaginous substance, and in some fishes is crusted over with a thin lamella to keep it from collapsing. The canals terminate in a cavity in which there is a bone or bones. These ear bones or ootolites, says Mr. Buckland, may "at once be classified and placed together in order of sizes: (1) the bones of the cod, (2) the hake, (3) the haddock, (4) the whiting, (5) the conger, (6) the turbot, (7) the sole, (8) the gurnard, (9) the smelt, (10) the salmon, (11) those of the trout. They all seem to be composed of a substance that has been called 'osseous ivory' or 'brain ivory,' but they differ much in shape and appearance." For instance, the ootolite of the conger is exactly the shape of a small sole, and an inch and two-eighths in length and three-eighths in width. That of the cod is nearly the size of a horse-bean split; the bone is curved upon itself, reminding one of a caterpillar in progression. Those of the haddock and whiting are much the same as those of the cod, but narrower. The ear bone of the conger is small, thin, and glass like. The ears of the turbot are shaped like the *haliotis* or "Venus's ear shell," but are deeply dentated on the margin. The ears of the sole remind one, on a small scale, of the cowry shell. Gurnards' ears are saucer shaped. Pilchards' ears consist of a bone folded on itself, much like a shrimp after boiling, only white. Salmons' ears consist of two parts, resembling a young salmon just hatched from the egg, and with the umbilical sac still attached. Trouts' ears are similar, but smaller. These ootolites are very much like strong porcelain, and may be easily obtained for study by boiling the head carefully, when the brain ivory may be detected.

THE PARASITIC LIFE ON SUBMARINE CABLES.

MR. J. MUNRO, having accompanied an expedition sent to repair the Para to Cayenne section of the Western and Brazilian Company's cables, gives us, in a recent number of *Chambers' Journal*, some account of the surprising amount of marine life that comes up on a cable after being immersed for a year or two. The writer's observations were made off the island of Marajo, in the estuary of the Amazon, where the work was chiefly done. The cable had been submerged for about a month only, yet it came on board the ship literally covered in some places with barnacles, at others overgrown with submarine vegetation, crabs, and curious shells often of singular delicacy and beauty. Clinging to the cable there were marine weeds in great profusion and variety; sometimes in thick masses of red and yellow algæ, slender, transparent, feathery, grass-like plants, red slimy fucoids, and tufts of moss-like plants of an amethystine color. There were found, too, branching corallines upwards of a foot in height growing on the cable, the soft skeleton being covered with a fleshy skin, generally of a deep orange color. Sometimes a sponge was found attached to the roots of the corals, and delicate calcareous structures of varied tints incrusted the stems of all these objects, and seemed not only to ornament but to strengthen them. Parasitic life seems to be as rife under these soft, tepid waters as it is on the neighboring tropical shores. Many star fishes, zoophytes, and curious crabs were likewise fished up on the cables. The crabs themselves were often completely overgrown with the indigenous vegetation of the bottom, and so were scarcely distinguishable from it. Others, although not thus covered, were found to possess the same tints as those of the vegetation they inhabited, and even in structure bore an external resemblance to the latter. Others, again, were perfectly or partially transparent, and one most beautiful hyaline crab, new to science, united in its person several of the prevailing colors of the bottom. Its slender limbs, resembling jointed filaments of glass, were stained here and there of a deep topaz brown. Its snout, pointed like a needle, was of a deep scarlet; its triangular body was orange yellow; its eyes were green, and its tiny claws were of an amethyst blue.

FISHERIES ON THE CANARY ISLANDS.

CONSUL DUNDAS states that the fisheries in these waters have been drawing much attention of late, and in proper hands they would develop into a source of considerable wealth—perhaps, the greatest, certainly not the least wealth producing source of these islands, by no means wanting in this respect. It is asserted that the fish are in general inferior in quality to those of Scotland or of British North America, but the imperfect and careless manner of curing them may account for this assertion. M. Berthelot, late French Consul, in his work, draws a comparison with the fisheries of Newfoundland. After elaborate numerical calculation derived from practical results, he comes to the conclusion that the quantity of fish caught by one man in the Canaries is equal to that caught by twenty-six men in Newfoundland. All evidence tends to show that the quantity caught is very great, and that the supply is inexhaustible. And yet neither the native fishermen nor the commercial community of the islands have endeavored to turn this immense field of wealth to any advantage, being satisfied thus far with confining their operations almost exclusively to the supply of the local consumption. The largest fish banks are said to be from the Island of Fuerteventura to Cabo Blanco. The vessels fish down to the latter point, and the larger ones sometimes go very near to Cape de Verd.

In 1864, a Spanish company was formed, having obtained a concession from the government to fish in these waters on a large scale. An Englishman was engaged to superintend the business, who brought with him several intelligent operators from England and Scotland. Some barrels of dried and pickled fish were sent to Spain, and are reported to have been much liked. But the death of the originator occurring shortly afterward, and the want of funds, caused the break-up of the establishment. There is, however, a very possible probability that fish will in future be exported from the Canary Islands, and that in considerable quantities. A French company in Marseilles has lately made a contract with the owners of the fishing vessels, by which the company is to receive as much fish as they can supply, or the company can take.

The fishing boats are employed nearly all the year, but the best season is during the winter months, say from September to October to the end of March; the fish then are in great numbers and in best condition. There is one summer month—June—in which fish are very plentiful, or more correctly speaking, the latter half of that month. The class of vessels employed in this occupation, formerly top-sail, are now fore-and-aft schooners, varying in size from 25 to 50 tons; they carry crews of from 18 and 20 to 30 and 40 men and boys, and are provided with two, three, or four boats. No nets are used, the fish being caught with hooks. Besides the different kinds of hooks and lines, they also carry rods or poles of from five to six feet in length, to the end of which is attached some six feet of line trimmed with several strong rough made hooks at a certain distance from each other. These are trailed along the surface of the water; a means of capture which frequently fills the vessel rapidly. They steer by the sun or stars, the compass being either unknown or its use despised. The crews, many of whom are boys, are not paid any wages, but a share in the profits, and it is a rule on board that until all the fish caught during the day has been salted no dinner or supper shall be served. The total number of vessels composing the fishing fleet in these Islands is reckoned at 20, of which 14 belong to Grand Canary, the rest to Palma, Fuerteventura, and Lanzarote.

As the fishing varies greatly according to circumstances, it is somewhat difficult to give a reliable average. It frequently happens that a vessel is out weeks before filling up a cargo sufficient to return with, and at other times they fill up in an incredibly short space of time; and when judging the quantity taken and the time it is taken in, the rude means employed must not be lost sight of, whereas if nets were used, the proportion would be much larger in a shorter space of time, though the wholesale destruction would probably be greater. According to the owner of one of these fishing schooners, one of those now under contract with the French company mentioned, four boats, under favorable circumstances, could deliver in less than two days more fresh fish than the steamer could carry. Ordinarily speaking, a boat of 40 tons might be loaded in three days. Other estimates give the catch per vessel per diem at from 15 to 30 quintals of 900 lbs. each. But there are days in which 50 quintals have been taken, and others again when not even 10 quintals have been caught. Cases are numerous of a vessel of 30 tons or so filling up in two days, when they happen to come on a bank where the fish has been drawn or scared from other banks in large shoals.

It is equally difficult, says Consul Dundas, to give a correct estimate of the weight of the fish, which also varies considerably; but for practical purposes it may suffice to say that most of them run 15 to 65 lbs. each, the greater proportion being from 20 to 30 lbs. Very small fish are rejected, and very large are objected to. The fishing ground may be considered as lying between the southern part of the island of Grand Canary and the same latitude on the African coast, or from about 15° to 32° or 33° north latitude along the northwest coast of Africa. The annual quantity caught is estimated at from 5,000 to 8,000 tons; the salting is done on board the vessels. It must not be supposed that codfish is the sole fish comprised in these fisheries; it does not bear a larger proportion than one-quarter or one-third, according to the season, of the total.

SHOWERS OF RED ASHES IN THE ATLANTIC.

IN the latitude of Cape Verd, travelers frequently observe showers of red ashes and a sort of dry fog. The material composing this mass of ashes was examined very many years ago by Ehrenberg, and that savant put forth the opinion that minute particles from all countries, conveyed by the air, formed at length a transparent zone of dust, which being whirled about by the wind, occasionally fell on the surface of the earth. The observations of Ehrenberg were made on an insufficient quantity of the material. More recently the phenomenon has been studied more profoundly by Mr. Hellmann, who has carefully examined the log books of 1,196 vessels that had passed through the latitude in question, from 1854 to 1871. The question as studied by him has been more especially from the standpoint of meteorology, and the conclusions arrived at are as follows:

The majority of dust showers take place in that zone of the Atlantic embraced between 9° and 16° north latitude. To the south of the 6th degree they are extremely rare, and the most southerly one that has been observed occurred in 2° 56' north latitude, and 26° west longitude. The two most westerly storms that have been seen took place in 38° west longitude, at about 300 miles from Cape Verd. Showers of ashes often occur simultaneously at different points of the "Dunkeln Mer" (or Dark Sea), as Ehrenberg called it. In one case these showers were separated from each other by a distance of 150 miles; they often last for several days. The surface over which they extend is variable, sometimes it is as much as 100,000 square miles.

NEW DISCOVERIES AT ANCIENT TROY.

AFTER an interruption of five years and a half, not idly spent, Dr. Schliemann has resumed his search for the buried Troy. The work of opening trenches on Mount Hissarlik began September 30, and the results have been communicated to the London *Times* in a series of letters. Having but two months to work in before winter should drive him from the field, Dr. Schliemann attacked the western and northern front of the circuit wall, the construction of which Homer ascribes to Poseidon and Apollo (Iliad vii., 453), as well as all that remains of the prehistoric mansion immediately to the northwest and west of the great gate, which he attributes to the ancient town's chief or king, because it is the largest and best built house in the city. In his previous search he found in it hundreds of remarkable objects, and discovered close to it the treasure now exhibited in the South Kensington Museum. The walls of this mansion are at a depth of 26 ft. to 28 ft. below the surface of the hill, and precisely like the cyclopean walls of the Royal Palace at Mycenæ and the cyclopean houses at Tiryns, as well as in perfect conformity to the architecture represented by the golden houses found in the Mycenian tombs. They can only have served as substructures to a stately and very elevated wooden building, Dr. Schliemann believes; for otherwise he is altogether at a loss to explain the huge masses of red, black, and yellow wood ashes, intermixed with charcoal, by which they are covered to a depth of 9 ft. to 10 ft. On these strata of *débris* had been erected, by the successors of the burnt city, another large mansion, which covered the whole of the gate, and of which he only cut away as much as was necessary to bring the latter to light; for he found these prehistoric mansions too curious, and he was afraid his statement—that the one stands on the ashes of the other—would otherwise meet with incredulity.

In a late letter Dr. Schliemann writes as follows:

"I have now cleared the whole entrance, and visitors will see that there are in reality three gates, of which the first two are 12¼ ft., the third 17½ ft. broad; beyond the third gate the masonry on either side of the passage continues still for 10 ft.; the threshold of the third gate is 3¼ ft. broad. But visitors ought to be reminded that the masonry of those gates and the passage formed merely the substructure to wooden works of defense, which must have been of enormous size, because otherwise those tremendous masses of wood ashes could not have been produced by their combustion, and the heat could not have been so great as to destroy even the large flat slabs with which the passage below the gates is paved. Those wooden works must have been here in the form of a tower many stories high and densely inhabited, otherwise we can again not explain the large number of hand millstones of trachyte and of rude stone hammers, as well as the masses of pottery found in the ashes; And this pottery does not consist of mixed fragments as in Mycenæ and Tiryns, but here we either find the vases entire, or, if they are broken, we find all their fragments together, and this appears to me only possible in wooden buildings consumed by fire."

The articles discovered in the course of the excavation embraced bronze weapons, double-handled goblets, large and small (the Homeric *depas amphikypellon*), whorls innumerable, bracelets, earrings, beside ivory needles five inches long, gems of red agate, rude idols in stone and marble, terra-cotta tripods, pottery of various kinds, and even a gold nugget such as might be dug up from Californian or Australian mines. Indeed, the collection is of a very mixed kind, and Dr. Schliemann expresses his amazement at finding specimens of high art "side by side with hundreds of stone hammers of the rudest kind, and in the midst of large masses of pottery, all of which is handmade except the plates, which appear to be the productions of man's first attempt to use the potter's wheel." By far the most interesting object he ever found in his excavations at Troy is, he considers, a dagger of steel four inches long. The blade, which is double-edged and in the form of an arrow, is 1 6-10 in. long, and in a perfect state of preservation, which Dr. Schliemann attributes to the antiseptic power of the red wood ashes, mixed with charcoal, in which he found it embedded, in the large mansion close to the gate, 28 ft. below the surface. In an urn containing bones and ashes was also found, among other objects, a piece of lustrous green Egyptian porcelain 2 2-10 in. long, 1 9-10 in. broad, and 1 15-100 in. thick. This is the first time that Dr. Schliemann has found Egyptian porcelain at Troy. A recent and noteworthy discovery is a distaff of wood found in the ancient mansion, at a depth of 28 ft. below the surface. It is 11 in. long, and has a large quantity of woolen thread wound lengthwise around it. The wood is well preserved, and the thread is black as coal, probably from being charred.

Perhaps the most remarkable and inexplicable of the discoveries made in all the strata of prehistoric *débris*, are billions of shells of cockles and muscles, no longer found on the shores of the Hellespont or the Ægean. Purple snails, oyster shells, and vertebræ of sharks are found sparingly, while boars' tusks are abundant.

ANCIENT GLAZED POTTERY.

HENRY GILLMAN described in the *American Naturalist* a pottery vessel taken from a burial mound near the south shore of Santa Fe Lake, Florida. It is constructed spirally upward of one continuous rope of clay. The great peculiarity about this piece of prehistoric pottery is that it is glazed on the inside, and no other glazed vessel has hitherto been dug up in Florida. Glazed pottery of ancient date has been made, however, by the Pueblo Indians in the far West, and remains of it can be found in abundance. It is probable that the Florida vessel is of a greater antiquity than the Pueblo specimens; but of this there is no positive evidence. It is remarkable that the modern Pueblo Indians, though they make pottery by spirally arranging a long, narrow cylinder of clay, as the ancient Indians did, have lost the art of imparting the glaze.

QUANTITATIVE DETERMINATION OF STARCH IN PAPER.—C. Wurster.—The author first determines the moisture, then the resin by boiling with alcohol to which a few drops of hydrochloric acid have been added. He then extracts the starch by prolonged boiling in equal parts of alcohol and water, also acidulated with hydrochloric acid, and then weighs the residual paper. The action of the hydrochloric acid occasions a loss of mineral constituents. Hence the ash must be determined both in the original and in the extracted paper, and the difference, which is almost constant, and amounts to 0·8 to 1·1 per cent., is deducted from the starch.—*Dingler's Polyt. Journal.*